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Reports to the President

For the year ended
June 30, 2001

MIT Massachusetts Institute of Technology

Reports to the President

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For the year ended
June 30, 2001

MIT Massachusetts
Institute
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TABLE OF CONTENTS

PRESIDENT **9**
In Special Recognition 17
Statistics for the Year 22
Enrollment Statistics 25
Personnel Changes 35

PROVOST **58**
Center for Advanced Educational Services 62
Center for Archaeological Materials/
Center for Materials Research in Archaeology and Ethnology 71
Council on Primary and Secondary Education 72
Office of Educational Opportunity Programs 74
McGovern Institute for Brain Research 75

CHANCELLOR **77**

ASSOCIATE PROVOST **80**
International Scholars Office 81

ASSOCIATE PROVOST FOR THE ARTS **83**
List Visual Arts Center 84
MIT Museum 88
Museum Loan Network Program 92
Office of the Arts 94

DEAN FOR UNDERGRADUATE EDUCATION **101**
Admissions Office 102
Office of Academic Services 103
Office of Career Services and Preprofessional Advising 106
Office of Minority Education 109
Office of the Registrar 111
ROTC Programs 112
Student Financial Services 114
Student Services Information Technology 117
Teaching and Learning Laboratory 117

DEAN FOR STUDENT LIFE **120**
Athletics, Physical Education, and Recreation Department 121
Campus Activities Complex 122
Counseling and Support Services 125
MIT Card Office 125
Office of Student Conflict Resolution and Discipline 126
Residential Life and Student Life Programs 127

DEAN FOR GRADUATE STUDENTS **132**
International Students Office 135

VICE PRESIDENT AND DEAN FOR RESEARCH **138**
Whitaker College of Health Sciences and Technology 139
Center for Environmental Health Sciences 139
Clinical Research Center 140
Division of Comparative Medicine 143
Harvard-MIT Division of Health Sciences and Technology 144
Center for Biomedical Engineering 156

Center for Environmental Initiatives 157
Center for Materials Science and Engineering 161
Energy Laboratory 165
Francis Bitter Magnet Laboratory 171
Haystack Observatory 176
MIT/Woods Hole Oceanographic Institute Joint Program in Oceanography 180
Nuclear Reactor Laboratory 181
Operations Research Center 185
Plasma Science and Fusion Center 188
Research Laboratory of Electronics 197
Sea Grant College Program 201
Technology and Development Program 212
Technology Licensing Office 214

DIRECTOR, LIBRARIES 215
Public Services 218
Collection Services 221
Administrative Services 224
Technology Planning and Administration 229
MIT Press 231

DIRECTOR, LINCOLN LABORATORY 243

DEAN, SCHOOL OF ARCHITECTURE AND PLANNING 250
Department of Architecture 253
Program in Media Arts and Sciences 259
Department of Urban Studies and Planning 261
Center for Advanced Visual Studies 268
Aga Khan Program for Islamic Architecture 269
Center for Real Estate 273
Media Laboratory 275

DEAN, SCHOOL OF ENGINEERING 281
Department of Aeronautics and Astronautics 288
Department of Chemical Engineering 292
Department of Civil and Environmental Engineering 300
Department of Electrical Engineering and Computer Science 305
Department of Materials Science and Engineering 309
Department of Mechanical Engineering 315
Department of Nuclear Engineering 319
Department of Ocean Engineering 327
Division of Bioengineering and Environmental Health 332
Engineering Systems Division 336
Artificial Intelligence Laboratory 339
Biotechnology Process Engineering Center 341
Center for Innovation in Product Development 346
Center for Technology, Policy, and Industrial Development 353
Center for Transportation Studies 363
Concourse 368
Industrial Performance Center 369
Integrated Studies Program 371
Laboratory for Computer Science 372
Laboratory for Electromagnetic and Electronic Systems 375
Laboratory for Information and Decision Systems 378
Laboratory for Manufacturing and Productivity 387
Leaders for Manufacturing 389

Materials Processing Center 391
Microsystems Technology Laboratories 396
Program in Polymer Science and Technology 398
Singapore-MIT Alliance 399
System Design and Management Program 402
Technology and Policy Program 404
Technology, Management, and Policy Program 405

DEAN, SCHOOL OF HUMANITIES AND SOCIAL SCIENCE 406
Humanities, Arts, and Social Science Office 410
Department of Economics 416
Department of Humanities 420
Anthropology 420
Foreign Languages and Literatures 421
History 425
Literature 427
Music and Theater Arts 429
Program in Writing and Humanistic Studies 432
Department of Linguistics and Philosophy 434
Department of Political Science 436
Comparative Media Studies 442
Program in Science, Technology, and Society 445
Center for International Studies 449
Program in Women's Studies 457

DEAN, SLOAN SCHOOL OF MANAGEMENT 461
Education 464
Research Centers and Groups 471
Administration and Services 477

DEAN, SCHOOL OF SCIENCE 482
Department of Biology 484
Department of Brain and Cognitive Sciences 486
Department of Chemistry 490
Department of Earth, Atmospheric, and Planetary Sciences 493
Department of Mathematics 498
Department of Physics 501
Center for Learning and Memory 503
George Russell Harrison Spectroscopy Laboratory 506
George R. Wallace, Jr. Astrophysical Observatory 508
Experimental Study Group 509
Laboratory for Nuclear Science 511
Center for Cancer Research 513
Center for Space Research 515

CHAIR OF THE FACULTY 517

EXECUTIVE VICE PRESIDENT 522
Finances
Audit Division 523
Financial Systems Services 525
Office of Budget and Financial Planning 526
Office of the Controller 529
Office of Sponsored Programs 531

Operations
Audio Visual Services 533
Campus Police 534
Copy Technology Centers 534
Endicott House 536
Environmental Programs Office and Environmental Health and Safety Office 536
Facilities 540
Parking and Transportation Office 545
Senior Counsel's Office 547

TREASURER OF THE CORPORATION 549

VICE PRESIDENT AND SECRETARY OF THE CORPORATION 550
Public Relations Services 550
Communications Office 550
Conference Services, Events and Information Center 551
News Office 552
Publishing Services Bureau 553
Web Communications Services 554
Office of the Secretary of the Corporation 555

VICE PRESIDENT FOR HUMAN RESOURCES AND EQUAL OPPORTUNITY OFFICER. 559
Affirmative Action/Equal Opportunity and Diversity Programs Office 560
Benefits Services 560
Compensation 562
Employment and Human Resources Services 564
Labor Relations 565
Organization and Employee Development 565
MIT Medical 567

VICE PRESIDENT FOR INFORMATION SYSTEMS 575

VICE PRESIDENT FOR RESOURCE DEVELOPMENT 584
Office of Principal Gifts 585
Office of Campaign Giving 586
Office of Gift Planning 586
Office of Donor Partnerships and Special Projects 586
Office of Communications and Donor Relations 587
Office of Development Research and Systems 587
Office of Foundation Relations and School Development Services 588
Office of Corporate Relations 588

ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT 589

TABLES AND CHARTS

Degrees Awarded, Academic Year 2000–2001 25
Number of Students by Course and Year, Fall 2000 27
Number of Women Students, Fall 2000 29
Number of International Students, Fall 2000 31
Number of Minority Undergraduate Students, Fall 2000 33
Number of Minority Graduate Students, Fall 2000 34
Enrollment in Humanities, Arts, and Social Sciences Subjects 2000–2001 412
Concentrations in All Fields of the Humanities, Arts, and Social Sciences Subjects June 2001 413
HASS Undergraduate Majors 414
HASS Graduate Students 414
HASS Minor Applications for Classes of 2000–2001 415
Faculty and Academic Staff Count as of October 2000 573

PRESIDENT

DISTURBING THE EDUCATIONAL UNIVERSE
Universities in the Digital Age—Dinosaurs or Prometheans?

TAKING THE FORK IN THE ROAD

If there is one experience common to every university president in the United States during the past decade or so, it is being accused of leading institutional dinosaurs down a path to rapid extinction in a digital age. Peter Drucker has decreed it. Editorial writers have shouted about it. Alumni and trustees have stated it. Some of our own colleagues agree.

The issue is simply stated. Does the future of education, learning, and training belong to a new machine-based digital environment, or will the best learning remain a deeply human endeavor conducted person-to-person in a residential campus setting? I believe the answer is "Yes"—to both.

We are at the proverbial fork in the road where we should, and will, take both paths.

There is not an ounce of doubt in my mind that the way we learn throughout our lives is and will continue to be profoundly influenced by the use of digital media, the Internet, the World Wide Web, and devices and systems yet to be developed.

We will inhabit continually evolving electronic learning communities, in which amazing new technologies will help us learn. Cognitive science, virtual environments, and new modes of interacting will all come into play in powerful ways. We will extend educational opportunities to people throughout the world in a more cost-effective manner. On-the-job, just-in-time learning will become the norm in many industries. And there will be new players in both the for-profit and non-profit educational domains.

But there is even less doubt in my mind that the residential university will remain an essential element of our society, providing the most intense, advanced, and effective education. Machines cannot replace the magic that occurs when bright, creative young people live and learn together in the company of highly dedicated faculty.

The residential research-intensive university will not only survive, it will prosper. If anything, its importance will grow as we continue to provide access to the brightest young men and women regardless of their social and economic backgrounds.

However, the residential university also will be enhanced by wise use of the new technologies. But every institution—new and old—must make some choices about the tactical and strategic role it will play in the digital age. There is not one grand solution. Indeed, I believe that it is too early to declare comprehensive positions and strategies. Rather, it is a time for substantial experimentation and calculated risks that will help us sort out opportunities and find effective paths.

I ask only two things as universities find their way in the digital age. First, our emphasis should be on one thing—the enhancement of learning. Second, from Day One we must build serious evaluation of educational effectiveness into our experiments.

As we undertake our experiments and developments, we must have some guiding visions. At MIT we have decided that one of our dominant visions is that of openness.

THE PRINCIPLE OF OPENNESS

OpenCourseWare

Consider the direct question "How is the Internet going to be used in education, and what is your university going to do about it?"

An answer from the MIT Faculty is this: Use it to provide free access to the primary materials for virtually all our courses. We are going to make our educational material available to students, faculty, and other learners, anywhere in the world, at any time, for free.

Why are we doing this?

The glory of American higher education is its democratizing reach. Its great landmarks—the establishment of land grant universities in the mid 19th century and the GI Bill at the close of World War II—spread knowledge and opportunity across our landscape on an unprecedented scale. As we have progressed from World War II to the age of the World Wide Web, we have built a system of higher education that is the envy of the world, and we have developed the Internet as a universal medium for rapidly distributing and accessing information. These forces must now combine to raise educational opportunity throughout the world.

The Internet will revolutionize all kinds of teaching and learning, and some of that will necessarily and appropriately be done in the for-profit world. But inherent to the Internet and the Web is a force for openness and opportunity that should be the bedrock of its use by universities.

Think about what a professor at a research university does. She works with her students and colleagues to discover new knowledge, shares those discoveries with the professional community through papers, seminars, and conferences, and brings it to the students in her classes. She is not only discovering the future through her research, she is bringing it right into the classroom, and using these new findings and insights to develop and refine the courses she teaches. The resulting course notes and outlines, reading lists, demonstrations, and assignments become the educational content that undergirds the actual pathways to learning—the discussions, debates, and discoveries that faculty and students engage in together.

We now have a powerful opportunity to use the Internet to enhance this process of conceiving, shaping, and organizing knowledge for use in teaching. In so doing, we can raise the quality of education everywhere.

The quality of education in universities and colleges across America has grown dramatically over the past 50 years, aided by outstanding textbooks and other formal educational materials produced by the faculty. In this century, a similar role will be played by sophisticated educational materials that will be commercially available in electronic form.

But the positive transformation of our universities came about even more through the young men and women who studied at our most cutting-edge institutions and went on to become faculty members at other schools across the land. They took with them the class notes, syllabi, and other materials they used as students and based their teaching on these materials—sampling, shaping, expanding, and improving them to fit their new contexts and students.

At MIT, we plan to speed this process to Internet time, by making the primary materials for nearly all of our 2,000 courses available on the World Wide Web, for use by anyone anywhere in the world. A new engineering university in Ghana, a precocious high school biology student in New Mexico, an architect in Madrid, a history professor in Chicago, or an executive in a management seminar down the hall at MIT will all find these materials freely and instantly available. Together they will build a web of knowledge that will enhance human learning worldwide.

The computer industry learned the hard way that closed software systems—based on a framework of proprietary knowledge—did not fit the world they themselves had created. The organic world of open software and open systems was the true wave of the future. Higher education must learn from this. We must create open knowledge systems as the new framework for teaching and learning.

In this spirit, MIT has asked itself, in the words of T. S. Eliot, "Do I dare...Disturb the universe?"

Our answer is yes. We call this project MIT OpenCourseWare (OCW). We see it as opening a new door to the powerful, democratizing, and transforming power of education.

We are pleased to have been joined by the Andrew W. Mellon Foundation and the William and Flora Hewlett Foundation in a partnership to launch MIT OCW.

Even as we gird our institutional loins to undertake this great adventure, the reaction to its announcement has been astounding. Some have likened it to the Gutenberg printing press and to the Great Library at Alexandria. This is a bit hyperbolic for my taste, but even as clear-eyed an observer as IBM's CEO, Lou Gerstner, recently stated to Wall Street analysts:

> What do you think happened when MIT put its entire course catalog on the Net, for free? If that didn't send a shiver through the higher education system in the world, I don't know what will.

We have received messages and letters from all over the world. One writer, a faculty member at another U.S. university, said

> As a boy, I used to get up early in the morning to watch "Mr. Wizard" on television, and I dreamed of a day when all university courses would be available on television for interested students. That day never came, but today I am delighted to learn that my vision was too limited and that MIT is at the vanguard of a new era in education.

Another message sums the dominant international reaction well:

> What I saw from your initiative is the possibility of a major global upgrade of education—professors in the U.S. and around the whole world, including those in little Uganda where I am from, will be inspired and motivated to be on par with MIT standards. The students will demand it because they will have access to high-end quality education, giving them opportunities for a better life and better access to other opportunities.... This is global, and I would like to thank you for your generosity, for your commitment to education and not just to quality content but to designing an environment that fosters curiosity and joy in learning.

MIT's opportunity to serve society in this new way is immense and we are organizing the systems and the services to the faculty that will be required to meet these high expectations.

It is very important to note that the radical concept of MIT OCW evolved through the deliberations of a faculty-led study of MIT's role in Internet-based education. As we rolled out the idea and discussed it with the faculty, we encountered some unexpected reactions and learned some important lessons.

There had been some apprehension that many would argue that we would be giving away too much potential intellectual property revenue. In fact, this argument was voiced by only a few. Almost all of our faculty saw it as a way to enhance our service to society and to improve education world wide, goals they considered to be more important than revenue possibilities.

In those discussions, however, there were other strong concerns that any university undertaking such a project must recognize. First, the undertaking should not detract from resources and innovation in our on-campus education. (Indeed, I believe that MIT OCW will lead to enhancement of on-campus education.) Second, we must generate sufficient funding to provide a high level of service, making it as easy as possible for faculty members to convert their materials to a high-quality Web format. Together with our foundation partners, we are committed to meeting these important criteria, and also to developing concepts and systems that will aid other universities who may join in the open courseware movement.

Open Systems

Much of the discussion and prognostication about the future of education has been based on "distance education," thought of as a form or analog of business-to-consumer electronic commerce. In such a model, lectures would be delivered to large numbers of students over the Internet, or through some variant of videoconferencing. The idea of MIT OCW is different. It is more related to business-to-business commerce. It is a form of sharing among institutions. It is a form of academic publishing more than of teaching. It puts materials in the hands of others to use as they see fit.

If sharing and pedagogical openness are to become major forces, there must be systems and platforms to support it. Here too, I believe that the spirit of open systems and of LINUX should prevail.

MIT and Stanford, together with partners that to date include the Mellon Foundation, Dartmouth College, North Carolina State University, the University of Pennsylvania, and the University of Wisconsin, are undertaking the Open Knowledge Initiative (OKI). This is a project to create an open-source system of web-based environments to support pedagogical sharing and the management of educational systems.

The project leader, Vijay Kumar of MIT, indicates that the primary goal of OKI is to design and develop an open and extensible architecture for learning management systems. OKI has other goals, but this is the foundation from which everything else springs. We intend OKI to become a community, a process, and an evolving open-source set of tools that will be of service to a very wide range of educational environments. If OKI is successful as an architecture, then it will inspire contributors to help us realize these other goals. It is ambitious and important.

OUTWARD AND INWARD

The new media enable us to reach out to the world and extend our learning community by teaching at a distance. They also enable us to bring the world in to our students on campus. Often, we arrive at an amalgam of the two.

MIT has for some time been engaged in so-called distance education. For example, our Sloan School of Management conducts ongoing seminars with management faculty in leading Chinese universities, and our System Design and Management program uses advanced videoconferencing and the Web to teach masters-level students in their work places around the country.

Last year, Andrew Lo of the Sloan School taught his popular course on investments to twenty eight Merrill Lynch directors, vice presidents, analysts, and associates in offices in Japan, Hong Kong, and Australia. With students with very busy professional schedules located in several countries, it would have been nearly impossible to conduct the classes and discussions simultaneously. Instead, Lo's formal lectures were made available on CD-ROM, which the students could use anywhere—on commutes, at home, or during non-trading hours at work. Faculty provoked discussions and answered questions, and students "met" with each other and the teaching staff at all hours—by e-mail, on the Web, and through a more primitive technology: the telephone. Despite their demanding schedules, the students committed themselves to 14 weeks of very hard work; what they got in return was an immersion course in global business as well as financial engineering.

The largest MIT experiment in distance education is the Singapore-MIT Alliance (SMA). MIT has worked since 1998 in partnership with the National University of Singapore (NUS) and the Nanyang Technological University (NTU) to develop world-class, research-based, highly interactive graduate engineering education across national and institutional boundaries. Students earn SMA-based graduate degrees from NUS or NTU through access to exceptional faculty and superior research facilities in all three institutions.

Walk into one of MIT's state-of-the art classrooms at 8:00 a.m., or at 8:00 p.m. this fall, and you will find students engaged in classes together with their counterparts in Singapore. Indeed, we are planning to beam 540 hours of instruction in 12 subjects to a total of 155 students. SMA subject areas range from advanced materials for micro- and nano-systems to manufacturing systems and technology to molecular engineering of biological and chemical systems. We believe that SMA, which is supported by a 155-megabytes-per-second Internet-2 line, is the world's most technologically advanced point-to-point synchronous educational program. It uses a dual-screen delivery technology that enables students to view simultaneously camera images from the classrooms and a computer screen for displaying PowerPoint presentations. This technology also makes it possible for MIT faculty to hold help sessions for the students and conduct oral examinations of doctoral students in Singapore.

Learning—not technology—is the goal of SMA. How is it going? Singapore and MIT students enrolled in the same classes are performing at comparable levels, but professors do report that there is a very steep learning curve for preparing and presenting lectures across these boundaries. Fortunately, however, they also report that in a modest amount of time they reach a point at which the technology ceases to dominate their planning and they are able to concentrate on educational quality.

Through these and many other experiments, we are extending our learning community by teaching outward from our campus in both synchronous and asynchronous modes—carrying MIT to the world.

But what about bringing the world inward to our primary students—those in residence on our own campus? Interesting examples have been developed in our School of Architecture and Planning, where our students use technology to interact with people and projects around the world. For example, student design projects are routinely evaluated by juries of distinguished architects on several continents, whose schedules would not allow them to convene here in Cambridge. They have monitored the progress of large international construction projects such as the new Hong Kong Airport. One term, a class was team-taught by Professor Bill Mitchell at MIT and architect Frank Gehry in Santa Monica, with Mayor Jerry Brown of Oakland, California, serving as the client for a project to design a reuse of an abandoned naval base.

Many other examples could be found throughout the Institute and across academia.

SHARING LABORATORIES, LIBRARIES, AND LECTURES

Scientists and engineers learn in laboratories as well as in classrooms. MIT professor Jesús del Alamo has developed WebLab, a novel on-line laboratory for conducting experiments to test microelectronic devices—a lab that is available to students 24 hours per day from their dorm rooms or elsewhere. Last fall, 120 students at MIT enrolled in three different courses and 20 students in Singapore performed remote measurements in real time on state-of the art devices located at MIT and at Compaq's development laboratories. At its busiest hour, WebLab handled 13 users running 99 different experiments.

WebLab has nucleated the development of a broader tool, I-Lab, which will ultimately be used for experiments in many different fields of study. "Bringing the lab to the student" has proved to be a great way for students to explore theory versus experiment as they study.

In the same spirit, the World Wide Web increasingly brings library resources to users wherever and whenever they need them. Some of this has become simply routine, but other aspects are in a fascinating stage of development.

Welcome to DSpace: an effort to capture, archive and distribute much of the intellectual output of MIT in the form of durable digital documents. It sounds simple. It is not, because while libraries know well how to manage books and papers, they are just starting to learn how to create and maintain digital libraries. Some of the challenges are technological, but the most difficult challenges derive from the profoundly different copyright environment that is emerging in the digital world. More about that later.

A more common vision is that of bringing a high-quality learning experience to students wherever and whenever they need it. There are many activities of this kind around the country, but a major effort at MIT has been directed to the development of PIVoT, the Physics Interactive Video Tutor. PIVoT enables students to adapt the use of course materials to their own learning styles. It includes the video segments that comprise the entire lecture set of our introductory physics course, a complete textbook, and a set of linked demonstrations and practice problems.

Students can readily navigate through the material by selecting topics or key words. A "personal tutor" monitors the student's path through the material and his or her performance on problems in order to make suggestions about areas to investigate or reinforce. Early indications are that the use of PIVoT does not lead to higher scores on basic tests, but appreciably improves conceptual understanding.

The level of expense and effort to develop such a tool, however, reminds us that in the long run we will need to find ways to share resources among institutions and rely on appropriate commercial development as well.

So much for laboratories and libraries. What about lectures? University campuses are replete with stunning lectures, performances, and events that should be shared beyond our boundaries. In our case, the demand for such access is especially strong among our alumni/ae and among engineers and managers in industry. To begin to bring such events to these and other constituencies, our Center for Advanced Educational Services (CAES) has joined forces with our Alumni Association and our Industrial Liaison Program to establish MIT World.

MIT World is a web site (http://mitworld.mit.edu/) that makes available on-demand videos of events on our campus. Indeed, our intent is for it to evolve into a 24-hour-a-day TV station on the World Wide Web. Currently it contains such events as lectures by linguist Noam Chomsky; economists Paul Samuelson, Bob Solow, and Franco Modigliani; physicist Frank Wilczek; biologist Eric Lander; planetary scientist Maria Zuber; space scientist Claude Canizares; and many others. Like MIT OCW, this is a means of sharing our intellectual largess with a broader community, and is an example of what we believe many universities will develop as well.

IMPROVING EDUCATION ON OUR CAMPUS—FUELING INNOVATION

Despite our status as a research university with global reach, our first duty is to the education of the students on our campus, and it is to this that the vast majority of our energy, resources, time, and innovation are directed. Technology has an increasingly important role in this core endeavor. In addition to bringing the world and its information resources to the desktop of each student, it makes possible new methods of teaching and learning.

Does the shibboleth that we should "replace the sage on the stage with the guide on the side" point to the future of university education? The jury is still out, but I believe that, by and large, that is the case. Prudent use of technology enables faculty to concentrate more on the learning process and less on the direct transmission of information. We are proud of the many exceptional lecturers on our campus. They inspire students and organize knowledge wonderfully. But there is increasing evidence that other, more flexible modes of teaching can better stimulate discovery and improve understanding of conceptual material.

A major endeavor in the use of studio learning at MIT is spearheaded by TEAL/Physics, led by Professor John Belcher. TEAL stands for "Technology Enabled Active Learning," and it will be used this fall to teach our electricity and magnetism course. Taught in newly designed facilities, its first goal is to reintroduce hands-on experiments into the large freshman introductory subjects; its second goal is to more fully and actively engage students in the introductory courses than is possible with a strict lecture format. This concept was pioneered at Rensselaer Polytechnic Institute and at North Carolina State University.

In studio teaching, lectures, recitations, and hands-on laboratories are merged into a single experience. Students work together in groups of nine per table in a specially equipped classroom. They make heavy use of computer simulations and visualizations. White boards are always available for impromptu discussions or explanations. Video projection screens make it possible to present and share materials in both impromptu and formal ways.

We will carefully evaluate performance in these classrooms and compare it with how students do in traditional lecture courses.

How does an institution foster and support major innovations like this? The answer is simple: Make funds available to those faculty members who want to reform or improve education and who have good ideas they want to try out. Our experience is that such funding will catalyze rapid progress, even in an institution with a long-standing commitment to teaching and learning.

We are fortunate to have established two such funds in addition to the resources that individual schools and departments provide. The first is a generous endowment established by Alex and Brit d'Arbeloff to promote excellence in MIT education. The second is a major program called I-Campus established by MIT in partnership with Microsoft. Both programs enable faculty, students, and staff to submit proposals that are judged by a committee of educators. Ten percent of the budget for each d'Arbeloff-funded project must be set aside to support careful evaluation of its effectiveness, and all I-Campus projects must have an assessment component in order to receive funding.

Currently the d'Arbeloff Fund supports fifteen projects, most associated with improvements of the freshman-year experience. They range from TEAL/Physics to a freshman project in solving complex problems. Last year, the freshman project—Mars 2000—explored the design of a mission to Mars to determine whether life exists there, drawing on many experts from outside MIT who acted as mentors and resources to the student teams. The results—in terms of intensity, engagement, and learning—appear to have been spectacular. Other funded projects ranged from pedagogical initiatives in basic mathematics to innovative advising and tutoring systems. Note that not all of these initiatives involve new uses of technology. The emphasis is on learning and on improving the student experience.

Similarly, the Microsoft I-Campus program currently funds thirteen projects that utilize computer technology to enhance learning or to effectively manage educational systems. These projects run the gamut from on-line teaching modules in electrical engineering, computer science, and fluid mechanics to collaboration at a distance in aerospace design courses. It funds work on cross-media archives to be used in teaching Shakespeare studies, and has enabled students to develop a wireless system for instantaneous interaction and feedback in the classroom, including real-time assessment of understanding.

LEGAL ENVIRONMENT AND INTELLECTUAL PROPERTY ISSUES

As higher education—and the world at large—begins to develop new tools for the digital age, it encounters many unanticipated obstacles, mostly stemming from our litigious society and regulators straining to regulate something quite new and different.

For example, one large corporation recognized that the tools embodied in PIVoT could be used to help pass along hard-earned "know how" to new generations of engineers and managers. The idea was simple: to establish a tutorial web site on which experienced "masters" would record their experiences, approaches, and life lessons regarding engineering and managerial problems. Newer staff could then gain an in-depth understanding of the craft through this professional "oral history."

This concept is excellent, and the goal is important in an age when fewer people devote long careers to a specific company or industry. In the end, however, it didn't fly very well. Why? The senior people were afraid that they would be the subjects of lawsuits if they recounted honestly mistakes of the past.

Or consider the issues associated with a library archive project like DSpace. If a traditional library owns a book, it can make that book available to anyone it chooses—library subscribers, students of the university, or anyone it lets enter its building. A library can do this because, as owner of that book, it has "first copy rights": *i.e.*, it can not only read the ideas contained in the book, it can offer them to anyone else.

However, today's digital materials do not generally afford such "first copy rights." Instead of "subscribing" to an electronic database, we "license" access to it. The original owner thus has far more control than with the traditional printed book. For example, a publisher can tell the library to whom it must restrict access. This flies in the face of the traditional openness of academic libraries.

How did this state arise? It is simple—the entertainment industry and its interests have guided the development of legislation that governs electronic media. A meaningful set of changes and exemptions must be worked out in Washington if digital libraries are to realize their promise for research, scholarship, and education.

Of course, one of the hottest questions in academia is who owns the intellectual property when a faculty member produces electronic teaching materials. We are all struggling with this, and certainly no uniform approach has evolved across U.S. colleges and universities. The question is complex because the potential forms of electronic teaching materials are complex. At MIT our policies are evolving, but are becoming more concrete.

Normally when a faculty member writes a book, he or she simply owns the copyright and can independently assign it to a publisher. The institution plays no role in this. But electronic educational materials may well not simply be a book in digital form. They may capture the essence of our classroom or laboratory experience. They may be highly interactive. It may be unclear whether they comprise teaching or publishing. They may be very time consuming and expensive to produce. How do we resolve this?

Insofar as possible, we are building our policies on the foundation of the basic mission of the institution, and what we expect of a faculty member in pursuit of that mission. We exist to discover and teach and to enable our faculty to achieve full, unfettered dissemination of their intellectual property. But we also expect their appropriate commitment of time and effort to this mission. We have long-standing processes for avoiding conflicts of commitment. Faculty should not enter into contracts with outside parties that would constrain their teaching or scholarly responsibilities at MIT. They also cannot disseminate intellectual property that impairs the rights of others associated with it.

The *Policies and Procedures* of MIT basically indicate that MIT owns intellectual property if "substantial" MIT resources were used to generate it. This will frequently be the case when sophisticated digital teaching materials are developed. But by no means is the matter cut and dried. Time and experience will be required to establish sound understanding and application of these policies.

THE SPECTRUM OF EDUCATIONAL TECHNOLOGY: WHAT'S NEXT?

In this essay I have tried to portray some of my views on the nature of research universities in the digital age. I find it to be a time in which educational experiments large and small must progress, and sense that it is a time in which a deep recommitment to effective teaching and learning is evolving. I have illustrated some of the phenomena by citing a few of the activities underway at MIT.

It seems to me that the vector of these activities points to what we should expect during the next decade or so: increasing collaborative activities and electronic learning communities, on both national and international scales; the development of tutorial and studio teaching, enhanced by digital tools; production of advanced simulations and visualizations; the development of sophisticated platforms for sharing web-based materials and for managing the educational enterprise; a myriad of devices and programs for interaction; and, I very much hope, the establishment of an OpenCourseWare movement to enhance education around the world. It must be a time of experimentation and risk taking. We must conceive and implement some very large-scale projects, and also make modest modification to existing ways of teaching.

This is a picture of somewhat chaotic, intellectually entrepreneurial evolution, as opposed to overwhelming revolution. That is in the spirit of the Internet and the World Wide Web that are the bases of much of the opportunity before us. But it is important to note that the technology must serve us as educators and learners, not the other way around. The concept of appropriate technology holds. It runs from a simple wireless Personal Response System (PRS) that allows students in a lecture hall to respond to a faculty member's query about their understanding of a concept to the Internet-2 connection that makes it possible for students in MIT and Singapore to have a shared, simultaneous learning experience.

Indeed, our rather revolutionary MIT OpenCourseWare initiative is based on relatively straightforward technology. The users of MIT OCW, for the foreseeable future, will mostly reduce its content to paper form, or use it as the foundation of lectures and seminars.

Looking beyond the relatively near horizon, however, is difficult. Why? Largely because the technological platforms will continue to evolve at blinding speed, and there will inevitably be discontinuous changes and surprises.

I would particularly look to the use of new interfaces and means of human-computer interaction, which can take simulation and interactive learning to the next level. This is part of the goal of Professor Hiroshi Ishii's "Tangible Bits" group in the MIT Media Lab. Their goal is to communicate digitally mediated senses of activity and presence

at the periphery of human awareness. For example, they are developing workbenches, walls, and rooms in which ambient light, sound, airflow, and water movement can display information.

Through these and other advances, the learner's interactions with his or her surroundings will soon involve all five senses, as the environment itself displays, receives, and conveys information in a myriad of forms. As they strive to understand basic concepts and learn to design or synthesize information in new ways, students will navigate virtual space and time.

DINOSAURS OR PROMETHEANS?

Now I return to the central question.

I believe that universities like MIT are making steady progress in using emerging electronic technologies to enhance and extend learning. But we must separate the wheat from the chaff, and we can only do this by keeping focused on the real objective—learning. We should not use these technologies just because they are there, or only because we see some potential revenues associated with them.

Above all, we must evaluate our educational experiments and new approaches in order to understand whether they improve learning. Evaluation is key. Understanding what doesn't work is as important as recognizing success.

Some of our experiences with long-distance collaborative design and mentoring were not successful. This was because we had not invested sufficiently in the use of expert technical operators of the videoconferencing systems. On the other hand, the simple Personal Response System has been used very effectively.

Two years ago, when Alex and Brit d'Arbeloff established their extraordinary fund to support improvements in the excellence of education at MIT, we held a daylong program of talks, proposals and brainstorming about teaching, expecting that people would focus on advances that could come from the use of digital media. Interestingly, digital media received almost no attention that day. The faculty and students were concerned about more fundamental goals and concepts. Nonetheless, in due course, many good proposals were made to this fund, and also to the Microsoft I-Campus initiative, that use electronic media and devices to improve pedagogy.

The real lesson of the MIT experience with educational technology, in my mind, is that it has forced us to rethink the educational process. Faculty engaged in these new approaches do believe that they have become better teachers—but not so much because of the technological extensions of their capability but because the process of designing the programs forces them to think in fresh ways about ancient techniques.

Thus we come full circle to the essential human quality of teaching and learning. It is our minds, our sharing spirits, our insights into our students, our quest to improve what we do, and our passion to explore new horizons that drive the quality of teaching and learning in a research university.

But we can do better in the future than in the past. That is the simple definition of progress, and this progress will be driven in part by new technological possibilities.

We are not dinosaurs. We are Prometheans.

Our progress will be driven by competition as well. Others, driven by emerging technological and market forces, will increasingly challenge our leadership in education. I welcome this, because a healthy mix of competition and cooperation fuels excellence.

We have new opportunities to form educational alliances across distance, time, institutions, and nations—alliances that will expand opportunity, learning, and understanding. This, too, I celebrate, because we and our students must be citizens of the world as well as of our own countries.

However, the energy, passion, and inventiveness of our residential students, together with an environment that combines research, scholarship, and teaching, is our greatest source of renewal and our greatest strength.

Charles M. Vest
September 2001

IN SPECIAL RECOGNITION

The academic year 2000–2001 brought several significant changes to MIT's senior academic and administrative leadership.

Chancellor Lawrence S. Bacow left the Institute at the end of the academic year to become the twelfth President of Tufts University. A member of the MIT Class of 1972, Professor Bacow served the Institute for over 20 years as a professor of environmental policy and as an academic leader. As Chancellor, he led efforts to implement the recommendations of the Task Force on Student Life and Learning, and played a major role in establishing MIT's alliance with Cambridge University.

Professor of City Planning Phillip L. Clay, Associate Provost since 1994, was appointed Chancellor effective July 1, 2001. In this role, Professor Clay is responsible for continuing the enhancement and integration of education, student life, and campus community. His responsibilities include oversight of major educational and international institutional partnerships; he chairs the Council on International Relationships and co-chairs the Council on the Environment.

In December 2000, Robert J. Silbey was appointed Dean of the School of Science, after service as Interim Dean. The Class of 1942 Professor of Chemistry and a Margaret MacVicar Faculty Fellow, Professor Silbey was co-chair of the Task Force on Student Life and Learning and served previously as head of the Department of Chemistry and Director of the Center for Materials Science and Engineering.

Larry G. Benedict, formerly Dean for Student Affairs at The Johns Hopkins University, joined the Institute as Dean for Student Life. Dr. Benedict's appointment completed implementation of a new organizational structure. The Dean for Undergraduate Education now oversees areas including Academic Services, Admissions, Career Services and Preprofessional Advising, Minority Education, ROTC, Student Financial Services and the Student Services Center, and Student Services Information Technology. Major areas reporting to the Dean for Student Life include Athletics, Physical Education and Recreation; the Campus Activities Complex and Office of Campus Dining; Counseling and Support Services; the MIT Card Office; and Residential Life and Student Life Programs.

Professor Steven R. Lerman, Class of 1922 Distinguished Professor and Director of the Center for Educational Computing Initiatives, completed his term as Chair of the Faculty, which was marked by thoughtful attention to questions of educational innovation. Professor Stephen C. Graves, Abraham J. Siegel Professor of Management and Engineering Systems and Co-Director, Leaders for Manufacturing Program and System Design and Management Program, succeeds Professor Lerman as Chair of the Faculty.

At the beginning of the year, the Provost announced the appointment of an Institute-wide Council on Faculty Diversity, charged with formulating plans for the recruitment and advancement of women and minority faculty throughout the Institute. Appointed Co-Chair of the Council was Nancy H. Hopkins, the Amgen Professor of Biology, who gained national recognition for her leadership in the Study of the Status of Women Faculty in the School of Science, published in 1999. The Provost and Chancellor are the other co-chairs of the new Council.

New academic department or program leaders whose service began during the year were Ellen T. Harris, Head, Music and Theater Arts Section; Professor Anthony T. Patera of the Department of Mechanical Engineering, Co-Director, Singapore-MIT Alliance; Candace L. Royer, Head, Department of Athletics, Physical Education, and Recreation; and Susan Slyomovics, Head, Anthropology Program.

Changes in the leadership of research activities included the appointments of Steven D. Eppinger, Director, Center for Innovation in Product Development; June L. Matthews, Director, Laboratory for Nuclear Science; Michael F. Rubner, Director, Center for Materials Science and Engineering; Richard J. Samuels, Director, and Stephen Van Evera, Associate Director, Center for International Studies; and Jeffrey H. Shapiro, Director, Research Laboratory of Electronics. David H. Marks was named Director of the new Laboratory for Energy and the Environment, formed through the merger of the former Energy Laboratory and Center for Environmental Initiatives.

Among notable changes in the administration during the past year were the appointments of Walter R. Bender, Executive Director, Media Laboratory; Anne P. Glavin, Director of Public Safety; Ronald E. Hasseltine, Assistant Dean for Finance, School of Science; Barbara Jablon, Director of Compensation and Human Resources Information Services, Human Resources; Nathaniel J. Johnson, Director of the Information Technology Support Process, Information Systems; William M. Kettyle, Medical Director, MIT Medical; Monica Lee, Director, Publishing Services Bureau; Laure Morris, Director, Office of Communications and Donor Relations, Resource Development;

Patti Richards, Senior Communications Officer, Public Relations Services; Judith V. Sager, Director of Gift Planning, Resource Development; and Frank D. Schimmoller, Chief Financial Officer, Lincoln Laboratory.

* * *

The honors bestowed on MIT's faculty and staff each year are a striking reminder of the outstanding quality of the Institute's education and research. The following summary touches on only a few examples of the awards and recognition earned by members of the MIT community during 2000–2001.

Two MIT professors were elected to membership in the National Academy of Sciences, one of the highest distinctions accorded within the scientific community. This year's new members from MIT were Provost Robert A. Brown, the Warren K. Lewis Professor of Chemical Engineering, and Dietmar Seyferth, the Robert T. Haslam and Bradley Dewey Professor of Chemistry Emeritus.

The National Academy of Engineering elected five new members from the MIT faculty: Professors Dimitri P. Bertsekas of the Department of Electrical Engineering and Computer Science (EECS); Rafael L. Bras of the Department of Civil and Environmental Engineering; James G. Fujimoto of EECS; Douglas A. Lauffenburger of the Department of Chemical Engineering, Co-Director of the Division of Bioengineering and Environmental Health; and Nancy A. Lynch of EECS.

Elected Fellows of the American Academy of Arts and Sciences were Alexander V. d'Arbeloff, Chairman of the MIT Corporation; Shafrira Goldwasser, the RSA Professor of Electrical Engineering and Computer Science; John Benjamin Heywood, the Sun Jae Professor of Mechanical Engineering; Barbara Imperiali, the Ellen Swallow Richards Professor of Chemistry; and Douglas A. Lauffenburger, Professor of Chemical Engineering and Bioengineering.

The Institute of Medicine elected to membership Peter S. Kim of the Howard Hughes Medical Institute and the Whitehead Institute for Biomedical Research, Professor in the Department of Biology, and Robert A. Weinberg, member of the Whitehead Institute for Biomedical Research and Professor of Biology.

Vahid Tarokh, Associate Professor in the Department of Electrical Engineering and Computer Science, was awarded the Alan T. Waterman Prize, the highest honor bestowed on young researchers by the National Science Foundation, in recognition of his work on space-time codes, which have significantly improved the performance and data rates of wireless communications.

Professor of Mechanical Engineering Alexander H. Slocum, a Margaret MacVicar Faculty Fellow, was named the 2000 State of Massachusetts Professor of the Year by the Carnegie Foundation for the Advancement of Teaching and the Council for Advancement and Support of Education.

Continuing the tradition of service to the government by the MIT community, Institute Professor Mildred S. Dresselhaus was named Director of the Office of Science in the Department of Energy.

Charles M. Vest, President of the Institute, received the Arthur M. Bueche Award of the National Academy of Engineering, which recognizes statesmanship in science and technology, including engagement with public policy issues and contributions to industry-government-university relationships.

Appointment as MacVicar Faculty Fellows recognized outstanding commitment to excellence in teaching on the part of six members of the faculty: Professors Mary C. Boyce of the Department of Mechanical Engineering; Anne M. Mayes of the Department of Materials Science and Engineering; David A. Mindell of the Program in Science, Technology, and Society; Heidi M. Nepf of the Department of Civil and Environmental Engineering; Janet Sonenberg of the Music and Theater Arts Section; and J. Kim Vandiver of the Department of Ocean Engineering.

Erich P. Ippen, the Elihu Thompson Professor of Electrical Engineering, was the recipient of the twenty-eighth annual James R. Killian, Jr., Faculty Achievement Award. The selection committee cited Professor Ippen for his establishment, with Charles Shank, of the field of femtosecond optics while both were working at Bell Laboratories.

Associate Professors Justine Cassell of the Program in Media Arts and Sciences and Seth Lloyd of the Department of Mechanical Engineering received the Harold E. Edgerton Faculty Achievement Award, which recognizes junior faculty for achievements in teaching, research, and service to the MIT community.

The Gordon Y Billard Award, recognizing individuals who have performed special services of outstanding merit to MIT, was given this year to Roberta Brooks and Carmen Lazo of the Building 4 Coffee Shop, operated by Aramark, and O. Robert Simha of the Office of the Executive Vice President.

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While we celebrate the accomplishments of the MIT community, we also salute the distinguished service and outstanding achievements of current and former colleagues who have passed away. They contributed greatly to the Institute, to the nation, and to the world of knowledge, and their careers are inspirations to us.

Professor Emeritus of Meteorology James M. Austin, noted for his pioneering modeling of the meteorology of air pollution, died on November 26, 2000, at the age of 85. After receiving two degrees from universities in his native New Zealand, Professor Austin completed an Sc.D. in meteorology at MIT in 1941, when he began teaching at the Institute. During World War II, Professor Austin served as a civilian consultant to the U.S. Air Force weather service in Europe, where his forecasting was a factor in the decisions on the final bombardment of Cherbourg, France, and the D-Day landing of airborne troops, as well as the movement of advance mobile weather stations across northern France. In recognition of his wartime service, he received the Medal of Freedom from President Truman in 1946. On June 9, 1948, he launched a nightly weather forecast on WBZ-TV — the first television program broadcast live from Boston. He was a professor of meteorology until 1983 and the first director of the Institute's Summer Session.

John M. Biggs, Professor Emeritus of Civil Engineering, died September 3, 2000, at the age of 80. Professor Biggs received an S.B. and an S.M. from MIT, joining the faculty in 1947 as an instructor. He was an expert in structural dynamics, earthquake engineering, wind forces in structures, the induction of bridge vibrations by traffic, and protective construction for nuclear sites. Professor Biggs helped design Boston's Central Artery, the John Hancock Towers in Boston and Chicago, and many nuclear power plants in the U.S. and abroad; he was named Construction Man of the Year by the *Engineering News-Record* in 1965. After his retirement from the faculty in 1982, he was active in civic and church activities in Sandwich, New Hampshire.

Marine geochemist and paleoceanographer John M. Edmond died on April 10, 2000, at the age of 57. Professor Edmond received the B.Sc. degree from the University of Glasgow (1965) and a Ph.D. from the University of California at San Diego (1970), where he studied at the Scripps Institution of Oceanography. He participated in the discovery and geochemical exploration of hydrothermal systems at the mid-ocean ridges, and led research that illuminated the chemical composition of remote rivers and lakes of South America, Siberia, and Tibet. Collaborating with colleagues around the world, Professor Edmond and his research group conducted groundbreaking work on oceanic particulate matter, trace elements, and radioisotopes. He is remembered as a kind and thoughtful teacher, attentive to the needs of students and engagingly enthusiastic about his own work.

One of the world's great theoretical nuclear physicists, Institute Professor Emeritus Herman Feshbach died December 22, 2000, at the age of 83. Professor Feshbach received a B.S. from the City College of New York in 1937, and a Ph.D. from MIT in 1942; he was on the Institute faculty for more than 50 years, ten of them as Head of the Department of Physics, before his retirement in 1987. He was a revered colleague and mentor — an advocate for women and minority faculty members and a spokesman for scientific freedom and opportunity. He helped found the Union of Concerned Scientists and is remembered for his activism in the antinuclear movement and his work in opening communications between western and Soviet scientists during the Cold War. Awarded the National Medal of Science in 1986, Professor Feshbach led the development of nuclear reaction theory, co-authored major textbooks, and was the long-time editor of the *Annals of Physics*.

Professor Emeritus Allen F. Henry of the Department of Nuclear Engineering, who came to MIT as a visiting professor and stayed for 32 years, died on January 28, 2001, at the age of 76. An accomplished classical pianist as a child, he went on to receive three degrees, one in chemistry and two in physics, from Yale University. Prevented by a knee injury from serving in the U.S. Army, he volunteered to drive an ambulance with British troops in India. Professor Henry, who developed mathematical models to describe neutron behavior in reactors, joined MIT in 1969 after 15 years as the manager of reactor theory and methods at the Bettis Atomic Power Laboratory in West Mifflin, Pennsylvania. He went on to serve on the advisory boards of several national laboratories. A dedicated and effective teacher, he was active in graduate education at both the departmental and Institute level.

Patrick M. Hurley, Professor Emeritus of Geology and Geochemistry, died on October 21, 2000, aged 88. A native of Hong Kong with degrees in mining engineering from Victoria College and the University of British Columbia, Professor Hurley received a Ph.D. from the Institute in 1940 and joined the faculty following World War II, when he worked on antisubmarine warfare and underwater ballistics. He was known for his work on the determination of

geological age and the application of nuclear physics to geology. He worked on the growth of the continental masses, continental drift, and early studies in plate tectonics; his book *How Old is the Earth?* was translated into 11 languages. Active in Institute governance, he served as Chair of the Faculty and chaired the search committee that led to the appointment of Jerome B. Wiesner as President and Paul E. Gray as Chancellor.

Stanley M. Jacks, retired Professor of Management, died on August 2, 2000, at the age of 83. After receiving a B.A. from Harvard in 1943, he served in the War Labor Board while attending Northeastern University Law School, where he graduated in 1946. He also earned an M.A. in Economics from Harvard in 1950. After teaching economics at MIT and labor-management relations and labor law at Simmons College, he joined the Sloan School faculty in 1959. An active arbitrator and mediator, at the Institute he pioneered the introduction of law-related courses to undergraduates and was involved in early efforts to promote the use of alternative dispute resolution techniques. After retiring in 1980, Professor Jacks devoted himself to the founding of the YMCA of Casco Bay, Maine. His son Tyler E. Jacks is Associate Professor of Biology.

Professor Emeritus Thomas H. Lee, a pioneer in developing modern management techniques, died on February 4, 2001, at the age of 77. Born in Shanghai, he earned a B.S. in mechanical engineering from Chiao Tung University in 1946 and was the Pan-Asia doubles champion in table tennis while in college. Following service in the army of the Republic of China, he worked in Shanghai for General Electric, which sent him to the United States for further training. He remained with G.E. in the U.S. for 30 years, also earning degrees from Union College and Rensselaer Polytechnic Institute. Professor Lee joined the MIT electrical engineering faculty in 1980 and served as Director of the Laboratory for Electromagnetic and Electronic Systems. He profoundly influenced the reinvigoration of American product design and manufacturing processes, and in 1988, a year after his retirement from the Institute, he founded the Center for Quality Management. In recent years, he had been active in the study of tactics to fight corruption in business and government worldwide.

Professor of Mathematics Franklin P. Peterson died suddenly of a stroke on September 1, 2000, at the age of 70. Professor Peterson, who joined MIT in 1958 after receiving a B.S. from Northwestern University and a Ph.D. from Princeton University, was an algebraic topologist, specializing in the study of cohomology rings, which bridge the boundary between abstract topology and other disciplines of geometry. His influence is felt today in the fundamental structures of and the interplay between geometric and algebraic topology. He was a dedicated and beloved teacher and collaborator who co-authored papers with 23 mathematicians, two of whom were his students. He served for a quarter-century as treasurer of the American Mathematical Society and is remembered as a bon vivant who played bridge, tennis, and table tennis with a rare combination of competitiveness and good humor.

Clifford G. Shull, Professor Emeritus of Physics, died on March 31, 2001, at the age of 85. Professor Shull shared the Nobel Prize in 1994 for his pioneering work in neutron scattering, a technique that reveals where atoms are within a material, just as richocheting bullets reveal where obstacles are in the dark. This has proven to be the most important single technique for elucidating the structure and dynamics of solids and fluids. A native of Pittsburgh, Professor Shull received a B.S. from the Carnegie Institute of Technology in 1937. After receiving a Ph.D. from New York University in 1941, he became a research physicist at Texaco. He joined the Oak Ridge National Laboratory following the end of World War II—one of many scientists eager to build on the information and technology developed in connection with the Manhattan Project—and began his pioneering work on neutron scattering. He joined the Institute faculty in 1955 and retired in 1986. Professor Shull's students and colleagues will remember his optimism, modesty, and contagious excitement for science.

Professor Emeritus Claude E. Shannon, a pioneer in modern digital communications and information theory, died on February 24, 2001, at the age of 84. He came to MIT as a graduate student, after having received B.S. degrees in mathematics and electrical engineering from the University of Michigan in 1936; he received an S.M. in electrical engineering and a Ph.D. in mathematics in 1940. A cryptographer, Professor Shannon joined Bell Labs in 1941. During World War II, his team's work on anti-aircraft detectors was crucial when German rockets were used in the blitz of England. In *A Mathematical Theory of Communication*, written in 1948, he theorized that the information content of a message consists of the number of 1s and 0s it takes to transmit it—an idea at the heart of today's information age. Holder of the Institute's Donner Professorship of Science from 1958 to 1978, Professor Shannon received the National Medal of Science in 1966. He will be remembered for a love of chess, his whimsical inventions, and for juggling while riding a unicycle in the hallways at Bell.

Irwin W. Sizer, Professor Emeritus of Biology and former dean of the Graduate School, known for his work in molecular biology and as a champion of women and minority students at MIT, died on September 11, 2000, at the age of 90. During a decade as Head of the Department of Biology, Professor Sizer oversaw the transition from a classical curriculum to a modern molecular biology program; his own work focused on the use of enzyme inhibitors as antibiotics and in chemotherapy. He was instrumental in the development of Whitaker College and graduate

programs including the joint program in oceanography with the Woods Hole Oceanographic Institute. Professor Sizer received his undergraduate degree from Brown University in 1931 and a Ph.D. from Rutgers—The State University of New Jersey in 1935; he spent the remainder of his career at the Institute. He and his wife, Helen, established the Irwin and Helen Sizer Department of Biology Career Development Professorship at the time of his retirement in 1996.

Professor Emeritus Dirk Struik, a specialist in differential geometry who gained international recognition as an historian of mathematics, died on October 22, 2000. A native of Rotterdam, Professor Struik was invited to MIT in 1926 by Professor Norbert Weiner after studying in Leiden, Rome, and Göttingen. He remained at the Institute, becoming an American citizen in 1934, but his political views led to his indictment in 1951 by a Middlesex County Grand Jury on charges that he had advocated the overthrow of the federal and state governments. MIT placed him on leave with pay pending a judicial decision. After the charges were dropped five years later, he was reinstated, although the Executive Committee of the MIT Corporation censured him for conduct unbecoming a member of the faculty, citing his use of the Fifth Amendment before the House Un-American Activities Committee and "his comparative lack of candor with members of the administration." Professor Struik continued to research and teach after his formal retirement in 1960; still intellectually active, he had celebrated his 106th birthday a few weeks before his death.

Richard Terrell, a Life Member Emeritus of the MIT Corporation, died on December 4, 2000, at the age of 81. Mr. Terrell spent his career at General Motors—he joined the photographic staff as a messenger at the age of 17 and retired 42 years later as Vice Chairman of the Board, with breaks for service in the Army Air Corps in Panama and in the Navy during World War II. He served on the boards of several leading industrial firms in addition to G.M. and also gave generously of his time to civic causes, playing a key role in the revitalization of the neighborhoods around G.M.'s headquarters in the late 1970s. He joined the MIT Corporation in 1974, and although his only college degree was the S.E., a three-month degree for senior executives from the Sloan School, he served on the boards of four other colleges or universities as well.

STATISTICS FOR THE YEAR

REGISTRATION

In academic year 2000–2001, student enrollment was 10,090, compared with 9,972 in 1999–2000. There were 4,258 undergraduates (4,300 the previous year) and 5,832 graduate students (5,672 the previous year). The international student population was 2,489, representing 8 percent of the undergraduate and 36 percent of the graduate populations. These students were citizens of 109 countries. (Students with permanent residence status are included with U.S. citizens.)

In 2000–2001, there were 3,335 women students (1,755 undergraduate and 1,580 graduate) at the Institute, compared with 3,287 (1,768 undergraduate and 1,519 graduate) in 1999–2000. In September 2000, 429 first-year women entered MIT, representing 42 percent of the class of 1,017 students.

In 2000–2001, there were, as self-reported by students, 2,780 minority students (1,984 undergraduate and 796 graduate) at the Institute, compared with 2,669 (1,996 undergraduate and 673 graduate) in 1999–2000. Minority students included 402 African Americans (non-Hispanic), 89 Native Americans, 594 Hispanic Americans, and 1,695 Asian Americans. The first-year class entering in September 2000 included 495 minority students, representing 49 percent of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 2000–2001 included 1,183 bachelor's degrees, 1,553 master's degrees, 10 engineer's degrees, and 492 doctoral degrees—a total of 3,238, compared with 3,199 in 1999-2000.

STUDENT FINANCIAL AID

During the 2000–2001 academic year, 2,304 undergraduates received a total of $54,077,871 in student financial aid, exclusive of student employment. While the number of needy students remained approximately the same, the total aid increased by 7.5 percent, reflecting a downturn in the economy in the United States and abroad.

Total grant assistance to undergraduates was $42,515,352, an increase of 12.4 percent. Of this grant assistance, $34,416,071, or 81 percent, came from MIT; $4,053,013, or 9.5 percent, from federal sources; and $4,046,268, or 9.5 percent, from outside sources. Endowed scholarships and current gifts funded 83 percent of the MIT grants; the remaining 17 percent came from unrestricted funds. The most significant change in undergraduate scholarship funding sources from the previous year was an increase in endowed scholarships and current gifts, as a result of the strong growth in the endowment, and a corresponding decrease in unrestricted funds. Unrestricted funds decreased from $11,331,998 in FY2000 to $5,782,633 in FY2001, a decrease of 49 percent.

Undergraduate students borrowing declined 7.2 percent, to $11,562,519. Of the total loans made to undergraduates, 80 percent ($9,286,708) came from federal sources and the remaining 20 percent from institutional sources.

Graduate and professional students borrowed $15,033,908, an increase of 5.2 percent from the previous year. Of the total loans made to graduate and professional students, $9,431,905, or 63 percent, came from federal sources and the remaining 37 percent from institutional sources.

CAREER SERVICES AND PREPROFESSIONAL ADVISING

MIT experienced a successful recruiting season in 2000–2001 despite the slowing economy, and the outlook for the coming year was similarly positive. The most sought-after students were those with skills, knowledge, and experience in information technology, particularly multimedia and Internet technologies. Starting salaries for those students also increased this year because of increased demand. The telecommunications, pharmaceutical, finance, and semiconductor industries have contributed noticeably to this demand. Electrical Engineering and Computer Science was the number-one department from which employers sought candidates, but employers have learned that students from a wide variety of MIT courses have substantial experience with information technology, and are willing to interview students in all majors and at all degree levels. Students were increasingly interested in entrepreneurship, biotechnology and pharmaceutical companies, and the business side of technical industries; interest in working for national defense laboratories has decreased. Salaries for doctoral graduates in engineering ranged on the average from $70,000 to $90,000, offers to master's candidates range from $55,000 to $70,000, and to bachelor's candidates from $45,000 to $54,000.

Over 650 employers participated in InterviewTrak, the on-line, web-based employment recruiting program of the Office of Career Services and Preprofessional Advising. Through this system, students, alumni/ae, and employers were able to communicate with each other throughout the job search process twenty-four hours a day and seven days a week. Currently, 10,716 students and alumni/ae are registered with the program.

In 2000, there were a total of 174 MIT applicants to medical school, 168 of them degree-holders. MIT students continued to do well despite higher criteria for acceptance. Of the seniors, 81 percent were accepted; of the graduate students, 57 percent; and of the alumni/ae, 59 percent. Applicants benefited from the counsel of 50 pre-medical advisors, including 21 faculty members from MIT and the Harvard-MIT Division of Health Sciences and Technology as well as 29 physicians and senior staff.

PRIVATE SUPPORT

Private support for FY2001 totaled $200.8 million and included $192.7 million in gifts, grants, and bequests and $8.1 million in support through membership in the Industrial Liaison Program. The total compares with $233.6 million in 2000, $209 million in 1999, $143.9 million in 1998, and $133.6 million in 1997. Gifts-in-kind for the past year (principally gifts of equipment) were valued at $6.2 million.

By source, gifts from alumni totaled $62.7 million; non-alumni friends: $15.9 million; corporations, corporate foundations, and trade associations: $53.1 million; foundations, charitable trusts, and other charitable organizations: $47.3 million; and others: $13.7 million.

FINANCES

Unrestricted revenues available for operations for FY2001 totaled $1.43 billion, and total operating expenses were $1.38 billion. Net assets decreased $0.3 million, reaching $7.9 billion at year-end. The market value of the MIT endowment at year-end was $6.3 billion, $0.3 million lower than the prior year.

The research revenues of departmental and interdepartmental laboratories, primarily on campus, totaled $410.1 million in FY2001, an increase of 8 percent from the prior year. Industrial sponsors as a group remained the largest source of sponsored funds at MIT, followed by the Department of Defense and the National Institutes of Health. Lincoln Laboratory reported revenues of $349.1 million, approximately equal to the $348.3 million in the previous year.

FACILITIES AND CAMPUS ENVIRONMENT

The academic year 2000–2001 saw a dramatic increase in the number and scale of construction activities on campus. The architectural metamorphosis now under way will add nearly one million square feet of state-of-the-art space to the Institute's 154-acre campus and will rejuvenate many existing facilities.

This was the first full year of operation for the Capital Projects Group in the Department of Facilities, which has built a strong and effective construction management operation geared to the scale of the Institute's current construction program, assembling a team of experienced, capable professionals in many fields. The Capital Projects Group has established a formal decision-making structure for project approval, reporting procedures to maintain strong oversight and accountability, and effective budgeting and projection capability. Throughout the building program, significant attention is being paid to issues of sustainability.

Such an extensive construction program has an inevitable impact on the daily operations of the Institute. In order to minimize disruption, the Department of Facilities has launched both a construction impact mitigation program and a comprehensive communications effort. Facilities is also working to preserve and enhance campus green space so that members of the community have outdoor places that provide a refuge from the noise and dirt of widespread construction sites.

During the year, work continued on many major projects:

- Design development for the Ray and Maria Stata Center for Computer, Information, and Intelligence Sciences continued even as construction proceeded on the underground garage. The slurry wall was completed in October 2000. Construction of the building is scheduled to begin in September of 2001, when the reinforced concrete structure for the below-grade facilities is complete.
- Excavation for Simmons Hall, the undergraduate residence on Vassar Street, started in mid-October. The 10-story dormitory is designed to include substantial space for activities that will support and enhance student life. The project is scheduled for occupancy at the beginning of the 2002–2003 academic year.
- Construction of the Albert and Barrie Zesiger Sports and Fitness Center began in September of 2000. The first phase includes a 50-meter Olympic pool and instructional pools with seating for 500 spectators, a health and fitness area, six squash courts, a multi-activity court, offices, and renovated locker rooms. The schematic design is complete for Phase II of the project, which will provide additional facilities on the site of the present Rockwell Cage.
- The conversion of 224 Albany Street (Building NW30) from an early 20th-century mill building to apartment-style housing for 120 graduate students began in July of 2000 and was on track for completion in August of 2001.

- The construction of graduate student housing at Sidney and Pacific Street proceeded at a brisk pace. This fast-track project was permitted in the fall, and construction began in January. The building, which will house approximately 700 students, will be occupied in the summer of 2002.
- Work continued along Vassar Street on the installation of underground utilities—including water mains, chilled water, fire protection water, telephone and electric duct banks, and steam piping—to support the Stata Center, Building NW30, the Zesiger Sports and Fitness Center, and Simmons Hall.
- The renovation of the Dreyfus Building for the Department of Chemistry continued. This comprehensive, phased renovation will provide a more efficient, safe, and code-compliant layout, address energy conservation issues, and complete repairs and upgrades to the exposed concrete skin.

Design development continued for the extension of the Media Laboratory and for a new streetscape along Vassar Street. Master planning began for expansion to the Sloan School and the School of Humanities, Arts, and Social Sciences in the East Campus, and an architect was selected for the project. Architects were also chosen for the Brain and Cognitive Science center; site selection entered its final phase and schematic design began.

The Design and Construction group within the Department of Facilities undertook a wide range of projects during the year, retrofitting the Bechtel Lecture Hall (Room 1-390) with state-of-the-art distance learning capabilities, completing phase II of renovations in Building 45 for the Capital Projects and Design and Construction groups, and completing work to accommodate the Center for Learning and Memory in Buildings E17 and E18. Two classrooms on the first and second floors of Building 1 were completed to the high standards established in recent years. Renovations to the Information Center in Building 7, completed in the spring, have greatly enhanced and improved MIT's "front door," and work is underway to clean and restore the masonry and lighting in Lobby 7.

ENROLLMENT STATISTICS

DEGREES AWARDED, ACADEMIC YEAR 2000–2001

ACADEMIC YEAR 2000–2001 OFFICE OF THE REGISTRAR

	S.B.	S.M.	M.Arch, MCP M.Eng, MBA	Engineer	PhD	ScD	Total
SCHOOL OF ARCHITECTURE							
Architecture	-	-	25	-	14	-	39
Undesignated	1	-	-	-	-	-	1
Architecture Studies	-	22	-	-	-	-	22
Art and Design	17	-	-	-	-	-	17
Building Technology	-	8	-	-	-	-	8
Media Arts and Sciences	-	21	-	-	11	-	32
Undesignated	-	1	-	-	-	-	1
Media Technology	-	1	-	-	-	-	1
Planning	7	-	-	-	-	-	7
Real Estate Development	-	31	-	-	-	-	31
Urban Studies and Planning	-	4	45	-	6	-	55
Visual Studies	-	2	-	-	-	-	2
Total	25	90	70	-	31	-	216
SCHOOL OF ENGINEERING							
Aeronautics and Astronautics	34	62	3	-	13	-	112
Aerospace Eng. Information Technology	1	-	-	-	-	-	1
Bioengineering and Environmental Health	-	2	-	-	7	1	10
Chemical Engineering	70	17	-	-	20	1	108
Undesignated	11	-	-	-	-	-	11
Chemical Engineering Practice	-	23	-	-	-	-	23
Civil Engineering	10	-	-	-	-	-	10
Civil and Environmental Engineering	-	41	62	2	18	2	125
Undesignated	2	7	-	-	-	-	9
Computer Science and Engineering	158	-	-	-	-	-	158
Electrical Science and Engineering	66	-	-	-	-	-	66
Electrical Engineering and Computer Science	144	110	201	2	70	3	530
Engineering and Management	-	49	-	-	-	-	49
Environmental Engineering Science	18	-	-	-	-	-	18
Logistics	-	-	11	-	-	-	11
Materials Science and Engineering	27	30	-	-	28	1	86
Undesignated	3	-	-	-	-	-	3
Mechanical Engineering	101	114	-	-	33	2	250
Undesignated	8	22	-	-	-	-	30
Naval Architecture and Marine Engineering	-	9	-	-	-	-	9
Naval Engineer	-	-	-	6	-	-	6
Nuclear Engineering	2	16	-	-	19	1	38
Undesignated	-	1	-	-	-	-	1
Ocean Engineering	5	7	-	-	9	1	22
Undesignated	-	1	-	-	-	-	1
Ocean Systems Management	-	8	-	-	-	-	8
Technology and Policy	-	45	-	-	-	-	45
Technology, Management and Policy	-	-	-	-	7	-	7
Transportation	-	19	-	-	2	-	21
Total	660	583	277	10	226	12	1,768

	S.B.	S.M.	M.Arch, MCP M.Eng, MBA	Engineer	PhD	ScD	Total
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCE							
Anthropology	1	-	-	-	-	-	1
Comparative Media Studies	-	2	-	-	-	-	2
Economics	41	4	-	-	12	-	57
Foreign Languages and Literatures	3	-	-	-	-	-	3
History	4	-	-	-	-	-	4
Humanities	4	-	-	-	-	-	4
Humanities and Engineering	5	-	-	-	-	-	5
Humanities and Science	3	-	-	-	-	-	3
Linguistics	-	-	-	-	5	-	5
Linguistics and Philosophy	1	-	-	-	-	-	1
Literature	2	-	-	-	-	-	2
Music	7	-	-	-	-	-	7
Philosophy	6	-	-	-	6	-	12
Political Science	9	9	-	-	16	-	34
Science, Technology, and Society	-	-	-	-	4	-	4
Writing	3	-	-	-	-	-	3
Total	89	15	-	-	43	-	147
SLOAN SCHOOL OF MANAGEMENT							
Management	-	28	382	-	14	-	424
Management Science	89	-	-	-	-	-	89
Management of Technology	-	57	-	-	-	-	57
Operations Research	-	11	-	-	3	-	14
Total	89	96	382	-	17	-	584
SCHOOL OF SCIENCE							
Atmospheric Science	-	2	-	-	-	-	2
Biology	90	1	-	-	37	-	128
Undesignated	18	-	-	-	-	-	18
Brain and Cognitive Sciences	30	2	-	-	5	-	37
Chemistry	24	4	-	-	32	-	60
Earth and Planetary Sciences	-	3	-	-	-	-	3
Earth, Atmospheric, and Planetary Sciences	10	-	-	-	11	-	21
Geosystems	-	4	-	-	-	-	4
Mathematics	78	-	-	-	15	-	93
Mathematics with Computer Science	15	-	-	-	-	-	15
Physics	55	6	-	-	35	-	96
Total	320	22	-	-	135	-	477
WHITAKER COLLEGE of Health Sciences and Technology							
Health Sciences and Technology	-	1	-	-	13	1	15
Medical Informatics	-	7	-	-	-	-	7
Total	-	8	-	-	13	1	22
Awarded Jointly with Woods Hole Oceanographic Institution:							
Biology	-	2	-	-	5	-	7
Civil and Environmental Engineering	-	-	-	-	1	-	1
Earth, Atmospheric, and Planetary Sciences	-	6	-	-	4	-	10
Electrical Engineering and Computer Science	-	1	-	-	-	-	1
Ocean Engineering	-	1	-	-	4	-	5
Grand Total	1,183	824	729	10	479	13	3,238

NUMBER OF STUDENTS BY COURSE AND YEAR, FALL 2000

FALL TERM 2000–2001 OFFICE OF THE REGISTRAR

Course	Year 1	2	3	4	5	Total Under-grads	Master/ Eng.	Doctoral Reg.	Doctoral Non-Res.	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING													
Architecture, IV	20	17	19	2		58	154	41	20	5	220	278	IV
Architecture, IV-B	-	-	1	-		1	-	-	-	-	-	1	IV-B
Urban Studies and Planning, XI	4	5	2	3		14	133	38	23	5	199	213	XI
Program in Media Arts and Sciences, MAS	-	-	-	-		-	84	57	-	-	141	141	MAS
Total	24	22	22	5		73	371	136	43	10	560	633	Total
SCHOOL OF ENGINEERING													
Aeronautics and Astronautics, XVI	-	-	33	5		38	155	64	2	3	224	262	XVI
Program 1 - Aerospace Engineering, XVI-1	59	37	-	1		97	-	-	-	-	-	97	XVI-1
Program 2 - Aerospace Eng. with Information Technology, XVI-2	11	13	-	-		24	-	-	-	-	-	24	XVI-2
Aeronautics and Astronautics, XVI-C (Internship)	-	2	4	-		6	-	-	-	-	-	6	XVI-C
Chemical Engineering, X	77	75	76	2		230	64	141	1	-	206	436	X
Chemical Engineering, X-C	1	1	3	1		6	-	-	-	-	-	6	X-C
Civil and Environmental Engineering, I	-	-	-	-		-	187	89	6	1	283	283	I
Civil and Environmental Engineering, I-A	-	2	-	-		2	-	-	-	-	-	2	I-A
Civil and Environmental Engineering, I-C	11	4	11	-		26	-	-	-	-	-	26	I-C
Civil and Environmental Engineering, I-E	12	12	14	3		41	-	-	-	-	-	41	I-E
Civil and Environmental Engineering, I-W (Woods Hole)	-	-	-	-		-	1	6	-	-	7	7	I-W
Electrical Engineering and Computer Science, VI	-	-	-	-		-	175	390	2	29	596	596	VI
Program 1 - Electrical Science and Engineering	37	48	40	5		130	-	-	-	-	-	130	VI-1
Program 2 - Electrical Engineering and Computer Science	209	182	119	12		522	-	-	-	-	-	522	VI-2
Program 3 - Computer Science and Engineering	117	95	125	15		352	-	-	-	-	-	352	VI-3
Electrical Engineering and Computer Science, VI-P (M.Eng.)	-	-	-	-		-	217	-	-	-	217	217	VI-P
Electrical Eng and Computer Science, VI-PA (M.Eng., Internship)	-	-	-	-		-	10	-	-	-	10	10	VI-PA
Program 1 - Electrical Science and Engineering	-	7	15	1		23	-	-	-	-	-	23	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	20	22	-		42	-	-	-	-	-	42	VI-2A
Program 3 - Computer Science and Engineering	-	9	13	-		22	-	-	-	-	-	22	VI-3A
Electrical Engineering and Computer Science, VI-W (Woods Hole)	-	-	-	-		-	1	1	-	-	2	2	VI-W
Materials Science and Engineering, III	20	13	6	-		39	101	77	1	1	180	219	III
Materials Science and Engineering, III-A	-	-	1	-		1	-	-	-	-	-	1	III-A
Materials Science and Engineering, III-B (Internship)	14	23	21	-		58	-	-	-	-	-	58	III-B
Materials Science and Engineering, III-C	-	-	1	-		1	-	-	-	-	-	1	III-C
Mechanical Engineering, II	74	77	86	12		249	188	179	1	4	372	621	II
Mechanical Engineering, II-A	9	6	8	1		24	-	-	-	-	-	24	II-A
Mechanical Engineering, II-B (Internship)	-	8	11	-		19	-	-	-	-	-	19	II-B
Mechanical Engineering, II-W (Woods Hole)	-	-	-	-		-	1	-	-	-	1	1	II-W
Nuclear Engineering, XXII	5	9	4	-		18	35	82	-	1	118	136	XXII
Ocean Engineering, XIII	3	5	6	1		15	37	12	2	-	51	66	XIII
Ocean Engineering, XIII-W (Woods Hole)	-	-	-	-		-	5	14	-	-	19	19	XIII-W
Naval Construction and Engineering, XIII-A	-	-	-	-		-	29	-	-	-	29	29	XIII-A
Ocean Systems Management, XIII-B	-	-	-	-		-	10	-	-	-	10	10	XIII-B
Division of Bioengineering and Environmental Health, BEH	-	-	-	-		-	2	63	-	-	65	65	BEH
Engineering Systems Division, ESD	-	-	-	-		-	104	24	-	-	128	128	ESD
System Design and Management, SDM	-	-	-	-		-	89	-	-	2	91	91	SDM
Total	659	648	619	59		1,985	1,411	1,142	15	41	2,609	4,594	Total

Course	Year 1	2	3	4	5	Total Under-grads	Master/ Eng.	Doctoral Reg.	Doctoral Non-Res.	Doctoral Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES													
Economics, XIV		27	30	23	4	84	1	121	11	2	135	219	XIV
Foreign Languages and Literatures, XXI-F		-	-	1	-	1	-	-	-	-	-	1	XXI-F
History, XXI-H		1	1	3	1	6	-	-	-	-	-	6	XXI-H
Literature, XXI-L		-	3	1	-	4	-	-	-	-	-	4	XXI-L
Music and Theater Arts, XXI-M		1	-	-	1	2	-	-	-	-	-	2	XXI-M
Writing and Humanistic Studies, XXI-W		-	2	-	1	3	-	-	-	-	-	3	XXI-W
Humanities, XXI		-	-	1	-	1	-	-	-	-	-	1	XXI
Humanities and Engineering, XXI-E		-	1	2	4	7	-	-	-	-	-	7	XXI-E
Humanities and Science, XXI-S		-	-	1	-	1	-	-	-	-	-	1	XXI-S
Linguistics and Philosophy, XXIV		1	4	5	-	10	-	63	6	1	70	80	XXIV
Political Science, XVII		2	5	7	2	16	10	64	18	2	94	110	XVII
Program in Comparative Media Studies, XXI-CMS		-	-	-	-	-	13	-	-	-	13	13	XXI-CMS
Program in Science, Technology, and Society, STS		-	-	-	-	-	-	20	4	-	24	24	STS
Total		32	46	44	13	135	24	268	39	5	336	471	Total
SLOAN SCHOOL OF MANAGEMENT													
Management, XV		95	82	68	19	264	730	73	4	15	822	1,086	XV
Management Fellows, XV-A		-	-	-	-	-	56	-	-	-	56	56	XV-A
Operations Research, OR		-	-	-	-	-	11	36	-	2	49	49	OR
Total		95	82	68	19	264	797	109	4	17	927	1,191	Total
SCHOOL OF SCIENCE													
Biology, VII		89	71	91	8	259	-	215	-	3	218	477	VII
Biology, VII-A		2	-	1	-	3	-	-	-	-	-	3	VII-A
Biology, VII-W (Woods Hole)		-	-	-	-	-	2	32	-	-	34	34	VII-W
Brain and Cognitive Sciences, IX		29	32	29	2	92	-	58	2	1	61	153	IX
Chemistry, V		29	31	23	-	83	2	225	1	1	229	312	V
Earth, Atmospheric, and Planetary Sciences, XII		13	5	7	4	29	10	79	-	-	89	118	XII
Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole)		-	-	-	-	-	4	46	1	-	51	51	XII-W
Mathematics, XVIII		61	40	37	5	143	-	107	2	2	111	254	XVIII
Mathematics with Computer Science, XVIII-C		14	10	15	-	39	-	-	-	-	-	39	XVIII-C
Physics, VIII		30	34	32	2	98	9	227	1	4	241	339	VIII
Physics, VIII-A		7	5	9	-	21	-	-	-	-	-	21	VIII-A
Total		274	228	244	21	767	27	989	7	11	1,034	1,801	Total
WHITAKER COLLEGE of Health Sciences and Technology													
Harvard-MIT Division of Health Sciences and Technology, HST		-	-	-	-	-	8	284	-	6	298*	298*	HST
Center for Advanced Educational Services, CAES		-	-	-	-	-	-	-	-	68	68	68	CAES
Undesignated Sophomores		12	-	-	-	12	-	-	-	-	-	12	UND
First Year	1,017	-	-	-	-	1,017	-	-	-	-	-	1,017	First Year
Special Undergraduate -- No Course		-	-	-	-	5	-	-	-	-	-	5	Special-NC
Grand Total	1,017	1,096	1,026	997	117	4,258	2,638	2,928	108	158	5,832	10,090	Grand Total
Not included in above totals:													
Foreign Study: 1 student in the second year, 15 students in the third year, and 9 students in the fourth year.													
Non-Institute Brandeis, NIR	-	-	-	-		-					6	6	NIR
Non-Institute Harvard, NIH	14	15	17	40		86					221	307	NIH
Non-Institute Tufts, NIT	-	3	8	-		11					-	11	NIT
Non-Institute Wellesley, NIW	-	17	16	32		65					-	65	NIW
Non-Institute Research Visitor, NIV	-	-	1	4		5					63	68	NIV
Non-Institute Exchange, NIE	-	-	-	7		7					2	9	NIE
Total	14	35	42	83		174					292	466	Total

*Number includes 179 students working on Harvard degrees only.

NUMBER OF WOMEN STUDENTS, FALL 2000

FALL TERM 2000–2001 OFFICE OF THE REGISTRAR

Course	Year 1	2	3	4	5	Total Under-grads	Master/ Eng.	Doctoral Reg.	Doctoral Non-Res.	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING													
Architecture, IV	13	14	9	1		37	64	25	11	2	102	139	IV
Architecture, IV-B	-	-	1	-		1	-	-	-	-	-	1	IV-B
Urban Studies and Planning, XI	2	3	1	2		8	66	17	14	2	99	107	XI
Program in Media Arts and Sciences, MAS	-	-	-	-		-	23	14	-	-	37	37	MAS
Total	15	17	11	3		46	153	56	25	4	238	284	Total
SCHOOL OF ENGINEERING													
Aeronautics and Astronautics, XVI	-	-	12	1		13	33	12	1	1	47	60	XVI
Program in Aeorspace Engineering, XVI-1	23	9	-	1		33	-	-	-	-	-	33	XVI-1
Program in Aeorspace Eng. Information Technology, XVI-2	1	6	-	-		7	-	-	-	-	-	7	XVI-2
Aeronautics and Astronautics, VI-C (Internship)	-	1	1	-		2	-	-	-	-	-	2	XVI-C
Chemical Engineering, X	41	52	39	2		134	19	40	1	-	60	194	X
Chemical Engineering, X-C	-	1	2	-		3	-	-	-	-	-	3	X-C
Civil and Environmental Engineering, I	-	-	-	-		-	45	23	2	-	70	70	I
Civil and Environmental Engineering, I-A	-	2	-	-		2	-	-	-	-	-	2	I-A
Civil and Environmental Engineering, I-C	7	1	4	-		12	-	-	-	-	-	12	I-C
Civil and Environmental Engineering, I-E	11	8	8	1		28	-	-	-	-	-	28	I-E
Civil and Environmental Engineering, I-W (Woods Hole)	-	-	-	-		-	1	1	-	-	2	2	I-W
Electrical Engineering and Computer Science, VI	-	-	-	-		-	35	72	-	7	114	114	VI
Program 1 - Electrical Science and Engineering	13	17	16	1		47	-	-	-	-	-	47	VI-1
Program 2 - Electrical Engineering and Computer Science	53	41	23	3		120	-	-	-	-	-	120	VI-2
Program 3 - Computer Science and Engineering	33	20	21	2		76	-	-	-	-	-	76	VI-3
Electrical Engineering and Computer Science, VI-P (M.Eng.)	-	-	-	-		-	48	-	-	-	48	48	VI-P
Electrical Eng and Computer Science, VI-PA (M.Eng., Internship)	-	-	-	-		-	4	-	-	-	4	4	VI-PA
Program 1 - Electrical Science and Engineering	-	2	5	-		7	-	-	-	-	-	7	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	9	8	-		17	-	-	-	-	-	17	VI-2A
Program 3 - Computer Science and Engineering	-	2	-	-		2	-	-	-	-	-	2	VI-3A
Electrical Engineering and Computer Science, VI-W (Woods Hole	-	-	-	-		-	-	1	-	-	1	1	VI-W
Materials Science and Engineering, III	9	8	3	-		20	27	16	-	1	44	64	III
Materials Science and Engineering, III-A	-	-	1	-		1	-	-	-	-	-	1	III-A
Materials Science and Engineering, III-B (Internship)	10	15	17	-		42	-	-	-	-	-	42	III-B
Materials Science and Engineering, III-C	-	-	1	-		1	-	-	-	-	-	1	III-C
Mechanical Engineering, II	28	26	29	3		86	40	19	-	-	59	145	II
Mechanical Engineering, II-A	2	2	3	-		7	-	-	-	-	-	7	II-A
Mechanical Engineering, II-B (Internship)	-	1	1	-		2	-	-	-	-	-	2	II-B
Nuclear Engineering, XXII	2	3	1	-		6	11	15	-	1	27	33	XXII
Ocean Engineering, XIII	1	3	1	-		5	7	3	-	-	10	15	XIII
Ocean Engineering, XIII-W (Woods Hole)	-	-	-	-		-	1	2	-	-	3	3	XIII-W
Naval Construction and Engineering, XIII-A	-	-	-	-		-	1	-	-	-	1	1	XIII-A
Ocean Systems Management, XIII-B	-	-	-	-		-	1	-	-	-	1	1	XIII-B
Division of Bioengineering and Environmental Health, BEH	-	-	-	-		-	1	32	-	-	33	33	BEH
Engineering Systems Division, ESD	-	-	-	-		-	29	8	-	-	37	37	ESD
System Design and Management, SDM	-	-	-	-		-	12	-	-	1	13	13	SDM
Total	234	229	196	14		673	315	244	4	11	574	1,247	Total

Course	Year 1	2	3	4	5	Total Under-grads	Master/ Eng.	Doctoral Reg.	Doctoral Non-Res.	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES													
Economics, XIV		9	17	14	2	42	1	39	2	2	44	86	XIV
Foreign Languages and Literatures, XXI-F		-	-	1	-	1	-	-	-	-	-	1	XXI-F
History, XXI-H		1	-	2	1	4	-	-	-	-	-	4	XXI-H
Literature, XXI-L		-	2	-	-	2	-	-	-	-	-	2	XXI-L
Music and Theater Arts, XXI-M		1	-	-	-	1	-	-	-	-	-	1	XXI-M
Writing and Humanistic Studies, XXI-W		-	1	-	-	1	-	-	-	-	-	1	XXI-W
Humanities and Engineering, XXI-E		-	-	1	3	4	-	-	-	-	-	4	XXI-E
Humanities and Science, XXI-S		-	-	1	-	1	-	-	-	-	-	1	XXI-S
Linguistics and Philosophy, XXIV		1	4	3	-	8	-	30	2	-	32	40	XXIV
Political Science, XVII		1	3	2	2	8	4	21	8	1	34	42	XVII
Program in Comparative Media Studies, XXI-CMS		-	-	-	-	-	9	-	-	-	9	9	XXI-CMS
Program in Science, Technology, and Society, STS		-	-	-	-	-	-	8	-	-	8	8	STS
Total		13	27	24	8	72	14	98	12	3	127	199	Total
SLOAN SCHOOL OF MANAGEMENT													
Management, XV		44	40	34	5	123	182	23	-	2	207	330	XV
Management Fellows, XV-A		-	-	-	-	-	9	-	-	-	9	9	XV-A
Operations Research, OR		-	-	-	-	-	-	9	-	-	9	9	OR
Total		44	40	34	5	123	191	32	-	2	225	348	Total
SCHOOL OF SCIENCE													
Biology, VII		74	48	55	5	182	-	101	-	-	101	283	VII
Biology, VII-A		2	-	1	-	3	-	-	-	-	-	3	VII-A
Biology, VII-W (Woods Hole)		-	-	-	-	-	2	18	-	-	20	20	VII-W
Brain and Cognitive Sciences, IX		18	23	17	2	60	-	18	-	-	18	78	IX
Chemistry, V		15	18	12	-	45	1	75	-	-	76	121	V
Earth, Atmospheric, and Planetary Sciences, XII		10	4	6	3	23	3	25	-	-	28	51	XII
Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole)		-	-	-	-	-	4	29	1	-	34	34	XII-W
Mathematics, XVIII		20	15	14	1	50	-	20	-	-	20	70	XVIII
Mathematics with Computer Science, XVIII-C		8	4	3	-	15	-	-	-	-	-	15	XVIII-C
Physics, VIII		14	7	8	-	29	1	24	-	1	26	55	VIII
Physics, VIII-A		1	1	-	-	2	-	-	-	-	-	2	VIII-A
Total		162	120	116	11	409	11	310	1	1	323	732	Total
WHITAKER COLLEGE of Health Sciences and Technology													
Harvard-MIT Division of Health Sciences and Technology, HST		-	-	-	-	-	1	81	-	1	83	83	HST
Center for Advanced Educational Services, CAES		-	-	-	-	-	-	-	-	10	10	10	CAES
Undesignated Sophomores		1	-	-	-	1	-	-	-	-	-	1	UND
First Year	429	-	-	-	-	429	-	-	-	-	-	429	First Year
Special Undergraduate -- No Course		-	-	-	-	2	-	-	-	-	-	2	Special-NC
Grand Total	429	469	433	381	41	1,755	685	821	42	32	1,580	3,335	Grand Total

NUMBER OF INTERNATIONAL STUDENTS, FALL 2000

FALL TERM 2000-2001 OFFICE OF THE REGISTRAR

Course	Year 1	2	3	4	Total UG	Master/ Eng.	Doctoral	Spec'l.	Total Grads	Grand Total	Course Number
SCHOOL OF ARCHITECTURE AND PLANNING											
Architecture, IV	3	-	1		4	65	34	4	103	107	IV
Urban Studies and Planning, XI	-	-	-		-	36	22	-	58	58	XI
Program in Media Arts and Sciences, MAS	-	-	-		-	39	15	-	54	54	MAS
Total	3	-	1		4	140	71	4	215	219	Total
SCHOOL OF ENGINEERING											
Aeronautics and Astronautics, XVI	-	-	2		2	65	38	-	103	105	XVI
Program 1 - Aerospace Engineering, XVI-1	5	1	-		6	-	-	-	-	6	XVI-1
Program 2 - Aerospace Eng. with Information Technology, XVI-2	4	1	-		5	-	-	-	-	5	XVI-2
Chemical Engineering, X	2	7	7		16	18	42	-	60	76	X
Civil and Environmental Engineering, I	-	-	-		-	112	52	-	164	164	I
Civil and Environmental Engineering, I-C	2	-	-		2	-	-	-	-	2	I-C
Civil and Environmental Engineering, I-E	1	-	-		1	-	-	-	-	1	I-E
Civil and Environmental Engineering, I-W (Woods Hole)	-	-	-		-	-	1	-	1	1	I-W
Electrical Engineering and Computer Science, VI	-	-	-		-	53	112	6	171	171	VI
Program 1 - Electrical Science and Engineering	1	5	2		8	-	-	-	-	8	VI-1
Program 2 - Electrical Engineering and Computer Science	21	15	9		45	-	-	-	-	45	VI-2
Program 3 - Computer Science and Engineering	12	8	15		35	-	-	-	-	35	VI-3
Electrical Engineering and Computer Science, VI-P (M.Eng.)	-	-	-		-	36	-	-	36	36	VI-P
Electrical Eng and Computer Science, VI-PA (M.Eng., Internship)	-	-	-		-	4	-	-	4	4	VI-PA
Program 1 - Electrical Science and Engineering	-	1	-		1	-	-	-	-	1	VI-1A
Program 2 - Electrical Engineering and Computer Science	-	8	7		15	-	-	-	-	15	VI-2A
Program 3 - Computer Science and Engineering	-	6	2		8	-	-	-	-	8	VI-3A
Electrical Engineering and Computer Science, VI-W (Woods Hole)	-	-	-		-	1	-	-	1	1	VI-W
Materials Science and Engineering, III	1	-	2		3	37	34	-	71	74	III
Materials Science and Engineering, III-B (Internship)	3	-	1		4	-	-	-	-	4	III-B
Mechanical Engineering, II	4	7	5		16	53	99	-	152	168	II
Mechanical Engineering, II-A	-	1	1		2	-	-	-	-	2	II-A
Nuclear Engineering, XXII	1	1	-		2	7	47	-	54	56	XXII
Ocean Engineering, XIII	-	-	1		1	19	10	-	29	30	XIII
Ocean Engineering, XIII-W (Woods Hole)	-	-	-		-	-	4	-	4	4	XIII-W
Naval Construction and Engineering, XIII-A	-	-	-		-	7	-	-	7	7	XIII-A
Ocean Systems Management, XIII-B	-	-	-		-	6	-	-	6	6	XIII-B
Division of Bioengineering and Environmental Health, BEH	-	-	-		-	-	17	-	17	17	BEH
Engineering Systems Division, ESD	-	-	-		-	60	12	-	72	72	ESD
System Design and Management, SDM	-	-	-		-	8	-	1	9	9	SDM
Total	57	61	54		172	486	468	7	961	1,133	Total
SCHOOL OF HUMANITIES AND SOCIAL SCIENCE											
Economics, XIV	4	3	4		11	1	61	2	64	75	XIV
Humanities, XXI	-	-	1		1	-	-	-	-	1	XXI
Humanities and Engineering, XXI-E	-	-	1		1	-	-	-	-	1	XXI-E
Linguistics and Philosophy, XXIV	-	-	-		-	-	40	-	40	40	XXIV
Political Science, XVII	-	1	-		1	5	24	-	29	30	XVII
Program in Comaprative Media Studies, XXI-CMS	-	-	-		-	3	-	-	3	3	XXI-CMS
Program in Science, Technology, and Society, STS	-	-	-		-	-	6	-	6	6	STS
Total	4	4	6		14	9	131	2	142	156	Total

Course	Year 1	2	3	4	Total UG	Master/ Eng.	Doctoral	Spec'l.	Total Grads	Grand Total	Course Number
SLOAN SCHOOL OF MANAGEMENT											
Management, XV		5	8	4	17	275	48	14	337	354	XV
Management Fellows, XV-A		-	-	-	-	36	-	-	36	36	XV-A
Operations Research, OR		-	-	-	-	5	22	2	29	29	OR
Total		5	8	4	17	316	70	16	402	419	Total
SCHOOL OF SCIENCE											
Biology, VII		7	2	4	13	-	16	1	17	30	VII
Biology, VII-W (Woods Hole)		-	-	-	-	1	8	-	9	9	VII-W
Brain and Cognitive Sciences, IX		-	2	2	4	-	21	-	21	25	IX
Chemistry, V		4	4	1	9	1	77	-	78	87	V
Earth, Atmospheric, and Planetary Sciences, XII		-	-	-	-	2	24	-	26	26	XII
Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole)		-	-	-	-	1	11	-	12	12	XII-W
Mathematics, XVIII		11	5	2	18	-	64	-	64	82	XVIII
Mathematics with Computer Science, XVIII-C		1	-	1	2	-	-	-	-	2	XVIII-C
Physics, VIII		6	6	6	18	3	101	-	104	122	VIII
Physics, VIII-A		-	-	3	3	-	-	-	-	3	VIII-A
Total		29	19	19	67	8	322	1	331	398	Total
WHITAKER COLLEGE of Health Sciences and Technology											
Harvard-MIT Division of Health Sciences and Technology, HST		-	-	-	-	3	43	2	48	48	HST
Center for Advanced Educational Services, CAES		-	-	-	-	-	-	30	30	30	CAES
First Year	84	-	-	-	84	-	-	-	-	84	First Year
Special Undergraduate -- No Course		-	-	-	2	-	-	-	-	2	Special-NC
Grand Total	84	98	92	84	360	962	1,105	62	2,129	2,489	Grand Total

NUMBER OF MINORITY UNDERGRADUATE STUDENTS, FALL 2000

FALL TERM 2000-2001 OFFICE OF THE REGISTRAR

COURSE NAME	YEAR 2				YEAR 3				YEAR 4				TOTAL			
	Af	Na	Hi	As	Af	Na	Hi	As	Af	Na	Hi	As	Af	Na	Hi	As
SCHOOL OF ARCHITECTURE AND PLANNING																
Architecture, IV	2	2	1	2	-	-	2	7	1	-	5	5	3	2	8	14
Urban Studies and Planning, XI	-	-	-	2	2	-	-	1	1	-	1	1	3	-	1	4
Total	2	2	1	4	2	-	2	8	2	-	6	6	6	2	9	18
SCHOOL OF ENGINEERING																
Aeronautics and Astronautics, XVI	-	-	-	-	-	-	-	-	3	1	3	3	3	1	3	3
Program 1 - Aeronautical Engineering, XVI-1	5	4	9	5	2	2	6	8	-	-	-	-	7	6	15	13
Program 2 - Aeronautical Eng. with Information Technology, XVI-2	-	-	1	1	1	-	3	1	-	-	-	-	1	-	4	2
Aeronautics and Astronautics, VI-C (Internship)	-	-	-	-	-	-	1	-	-	-	-	2	-	-	1	2
Chemical Engineering, X	12	-	9	19	9	-	8	20	14	-	9	24	35	-	26	63
Chemical Engineering, X-C	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3
Civil and Environmental Engineering, I-A	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
Civil and Environmental Engineering, I-C	1	-	2	1	-	-	1	1	1	2	1	1	2	2	4	3
Civil and Environmental Engineering, I-E	-	1	-	2	-	1	2	1	2	-	3	3	2	2	5	6
Electrical Engineering and Computer Science, VI																
Program 1 - Electrical Science and Engineering	2	1	1	10	3	2	6	14	2	-	3	17	7	3	10	41
Program 2 - Electrical Engineering and Computer Science	21	4	27	60	9	3	22	67	13	2	11	52	43	9	60	179
Program 3 - Computer Science and Engineering	7	2	11	31	5	1	4	30	6	5	7	28	18	8	22	89
Electrical Engineering and Computer Science, VI-A (Internship)																
Program 1 - Electrical Science and Engineering	-	-	-	-	-	-	-	3	1	-	-	6	1	-	-	9
Program 2 - Electrical Engineering and Computer Science	-	-	-	-	-	-	1	6	1	1	1	6	1	1	2	12
Program 3 - Computer Science and Engineering	-	-	-	-	-	-	-	1	-	-	-	7	-	-	-	8
Materials Science and Engineering, III	-	-	3	3	1	-	1	5	-	-	-	2	1	-	4	10
Materials Science and Engineering, III-A	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Materials Science and Engineering, III-B (Internship)	-	-	-	7	4	-	1	8	1	-	1	8	5	-	2	23
Mechanical Engineering, II	2	3	15	11	6	1	17	10	4	-	24	21	12	4	56	42
Mechanical Engineering, II-A	-	1	3	3	-	-	1	1	1	-	1	2	1	1	5	6
Mechanical Engineering, II-B (Internship)	-	-	-	-	-	-	1	1	1	-	4	4	1	-	5	5
Nuclear Engineering, XXII	1	1	-	-	-	-	2	1	1	1	1	1	2	2	3	2
Ocean Engineering, XIII	-	-	1	-	-	1	-	-	1	-	1	-	1	1	2	-
Total	51	17	82	153	40	11	78	178	52	12	70	191	143	40	230	522
SCHOOL OF HUMANITIES AND SOCIAL SCIENCE																
Economics, XIV	1	-	3	6	-	1	-	11	2	1	1	6	3	2	4	23
Foreign Languages and Literatures, XXI-F	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
History, XXI-H	-	1	-	-	-	-	1	-	-	-	-	1	-	1	1	1
Humanities and Engineering, XXI-E	-	-	-	-	1	-	-	-	1	-	2	-	2	-	2	-
Literature, XXI-L	-	-	-	-	-	-	1	1	-	-	-	1	-	-	1	2
Music and Theater Arts, XXI-M	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
Writing and Humanistic Studies, XXI-W	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-	1
Linguistics and Philosophy, XXIV	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	2
Political Science, XVII	-	-	1	-	-	-	-	1	1	-	1	2	1	-	2	3
Total	1	1	5	6	1	2	2	15	4	1	5	12	6	4	12	33
SLOAN SCHOOL OF MANAGEMENT																
Management, XV	7	4	14	39	4	1	8	29	8	1	10	34	19	6	32	102
SCHOOL OF SCIENCE																
Biology, VII	4	-	3	37	2	1	7	27	2	1	9	43	8	2	19	107
Biology, VII-A	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	3
Brain and Cognitive Sciences, IX	2	3	4	4	2	-	2	9	3	1	1	6	7	4	7	19
Chemistry, V	-	1	2	9	1	-	-	11	-	-	4	5	1	1	6	25
Earth, Atmospheric, and Planetary Sciences, XII	1	-	1	1	1	1	-	-	1	-	3	1	3	1	4	2
Mathematics, XVIII	3	1	3	11	2	-	1	10	-	1	3	5	5	2	7	26
Mathematics with Computer Science, XVIII-C	-	-	2	2	1	-	-	2	-	-	3	2	1	-	5	6
Physics, VIII	-	-	1	8	1	1	1	3	4	-	2	4	5	1	4	15
Physics, VIII-A	-	-	1	1	-	-	-	2	-	-	-	1	-	-	1	4
Total	10	5	17	75	10	3	11	64	10	3	25	68	30	11	53	207
Undesignated Sophomores	1	1	1	1	-	-	-	-	-	-	-	-	1	1	1	1

	YEAR 1															
	Af	Na	Hi	As												
First Year	63	15	134	283	-	-	-	-	-	-	-	-	-	-	-	-	63	15	134	283
Grand Total	63	15	134	283	72	30	120	278	57	17	101	294	76	17	116	311	268	79	471	1,166

* Af = African American, Na = Native American, Hi = Hispanic American, As = Asian American.

NUMBER OF MINORITY GRADUATE STUDENTS, FALL 2000

FALL TERM 2000-2001

OFFICE OF THE REGISTRAR

COURSE NAME	MASTER/ENG				DOCTORAL +				SPECIAL				TOTAL			
	Af	Na	Hi	As	Af	Na	Hi	As	Af	Na	Hi	As	Af	Na	Hi	As
SCHOOL OF ARCHITECTURE AND PLANNING																
Architecture, IV	3	-	1	17	-	-	1	2	-	-	-	-	3	-	2	19
Urban Studies and Planning, XI	10	-	5	9	4	-	2	1	-	-	-	-	14	-	7	10
Program in Media Arts and Sciences, MAS	-	-	-	5	1	-	3	2	-	-	-	-	1	-	3	7
Total	13	-	6	31	5	-	6	5	-	-	-	-	18	-	12	36
SCHOOL OF ENGINEERING																
Aeronautics and Astronautics, XVI	6	-	6	12	-	-	-	2	-	-	-	-	6	-	6	14
Chemical Engineering, X	1	1	1	1	3	-	3	11	-	-	-	-	4	1	4	12
Civil and Environmental Engineering, I	2	-	6	7	1	-	4	5	-	-	-	-	3	-	10	12
Civil and Environmental Engineering, I-W (Woods Hole)	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
Electrical Engineering and Computer Science, VI	6	-	6	15	11	1	6	63	-	1	1	2	17	2	13	80
Electrical Engineering and Computer Science, VI-P (M.Eng.)	8	-	7	68	-	-	-	-	-	-	-	-	8	-	7	68
Electrical Eng and Computer Science, VI-PA (M.Eng., Internship)	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5
Materials Science and Engineering, III	3	-	1	12	-	-	-	5	-	-	-	-	3	-	1	17
Mechanical Engineering, II	10	2	4	24	5	-	1	12	-	-	-	-	15	2	5	36
Nuclear Engineering, XXII	3	-	1	5	-	-	2	2	-	-	-	-	3	-	3	7
Ocean Engineering, XIII	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
Naval Construction and Engineering, XIII-A	1	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-
Division of Bioengineering and Environmental Health, BEH	-	-	-	-	2	-	2	9	-	-	-	-	2	-	2	9
Engineering Systems Division, ESD	-	-	1	5	-	-	-	1	-	-	-	-	-	-	1	6
System Design and Management, SDM	1	-	1	5	-	-	-	-	-	-	-	1	1	-	1	6
Total	41	3	35	161	22	1	19	110	-	1	1	3	63	5	55	274
SCHOOL OF HUMANITIES AND SOCIAL SCIENCE																
Economics, XIV	-	-	-	-	3	-	1	7	-	-	-	-	3	-	1	7
Linguistics and Philosophy, XXIV	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	1
Political Science, XVII	-	-	-	1	-	-	1	3	-	-	1	-	-	-	2	4
Program in Comparative Media Studies, XXI-CMS	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Total	-	1	-	1	4	-	2	11	-	-	1	-	4	1	3	12
SLOAN SCHOOL OF MANAGEMENT																
Management, XV	32	1	28	69	-	-	2	4	-	-	-	-	32	1	30	73
Management Fellows, XV-A	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Operations Research, OR	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4
Total	32	1	28	70	-	-	2	8	-	-	-	-	32	1	30	78
SCHOOL OF SCIENCE																
Biology, VII	-	-	-	-	4	1	2	26	-	-	-	-	4	1	2	26
Biology, VII-W (Woods Hole)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Brain and Cognitive Sciences, IX	-	-	-	-	1	-	-	2	-	-	-	-	1	-	-	2
Chemistry, V	-	-	-	-	5	1	6	8	-	-	-	-	5	1	6	8
Earth, Atmospheric, and Planetary Sciences, XII	-	-	-	2	-	-	1	2	-	-	-	-	-	-	1	4
Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole)	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4
Mathematics, XVIII	-	-	-	-	-	-	1	4	-	-	-	-	-	-	1	4
Physics, VIII	-	-	-	-	2	1	3	12	-	-	1	-	2	1	4	12
Total	-	-	-	2	12	3	13	59	-	-	1	-	12	3	14	61
WHITAKER COLLEGE of Health Sciences and Technology																
Harvard-MIT Division of Health Sciences and Technology, HST	-	-	-	-	4	-	9	67	1	-	-	-	5	-	9	67
Center for Advanced Educational Services, CAES	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Grand Total	86	5	69	265	47	4	51	260	1	1	3	4	134	10	123	529

*Af = African American, Na = Native American, Hi = Hispanic American, As = Asian American
+ Includes Regular and Non-Resident students.

PERSONNEL CHANGES

CORPORATION

Deaths
Richard L. Terrell
Member

Resignations
Argeo Paul Cellucci
Member

Changes of Appointment
Angus N. MacDonald
Life Member, Emeritus

Kenneth H. Olsen
Life Member, Emeritus

Elections
Philip M. Condit
Member

Thomas P. Gerrity
Member

Mark P. Gorenberg
Member

Homayoun Hatami
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PROVOST

Academic year 2001 saw significant advances in academic and educational programs and initiatives. Some of these advances are highlighted in this summary. Others are described in the reports of programs, departments and schools, which follow.

PEOPLE

The academic year 2001 saw several changes in the membership of the Academic Council and Dean's Committee. After receiving input from a faculty advisory committee, Professor Robert J. Silbey, Class of '42 Professor of Chemistry, was appointed the Dean of Science effective January 1, 2001

In January 2001, Professor J. David Litster announced his intentions to step down as Vice President and Dean of Research effective July 1, 2001. The Provost and Chancellor consulted with faculty leaders and initiated a search for Professor Litster's replacement. Professor Alice Gast, of Stanford University, accepted the position in June 2001 and will join the MIT faculty as Professor of Chemical Engineering and Vice President and Associate Provost in the fall of 2001. Professor Litster has agreed to stay in the position on an interim basis until Professor Gast joins MIT.

Professor Steven R. Lerman of the Department of Civil and Environmental Engineering concluded his two years of exemplary service as Chairperson of the MIT Faculty in June 2001. Professor Lerman will be on sabbatical leave in Academic year 2002. The new Chair of the Faculty is Professor Stephen C. Graves, Abraham Siegal Professor of Management of the Sloan School of Management.

Professor Nancy Hopkins of the Department of Biology joined the Academic Council and the Dean's Committee in recognition of her appointment as co-Chairperson of the Council on Faculty Diversity.

A major change in the senior administration of MIT occurred when Professor Lawrence S. Bacow resigned as Chancellor of MIT in summer of 2001 to assume the Presidency of Tufts University. President Vest appointed Phillip L. Clay, Professor of Urban Studies and Planning and Associate Provost, as the Chancellor effective July 2001. Chancellor Clay will have responsibility for the Offices of the Deans of Undergraduate Education, Student Life, of Graduate Students, and for coordination of MIT's corporate and academic institutional partnerships.

The position of Associate Provost, replacing Professor Clay, will be filled by the fall of 2001. The position will be reconstituted to have a major role in space planning, utilization, construction, and management for all of MIT.

FACILITIES

The Institute remained committed to an aggressive plan for renovation of physical facilities and to the construction of new facilities. The process for prioritizing and planning space renovations was led by Chancellor Bacow who was Chair of the Committee for Review of Space Planning (CRSP). In FY2001 MIT allocated over $24 million in funds for this purpose. Several major renovations were carried out in AY2001. These include the continued, staged renovation of the Dreyfus Chemistry Building, Building 18, and the completion of the renovation of Building 33 for research and teaching facilities for the Department of Aeronautics and Astronautics. In addition, two classrooms in Building 3 were renovated (3-270 and 3-370), and a Technology Enabled Active Learning (TEAL) classroom was built in Room 12-152.

Construction continued on the Ray and Maria Stata Center which will be the home of the Laboratory of Computer Science, the Artificial Intelligence Laboratory, the Laboratory for Information and Decision Systems, and the Department of Linguistics and Philosophy. The Stata Center will also house a major childcare facility, teaching facilities, and significant social space for students, staff and faculty. Design continued on the expansion of the Media Laboratory, which is being designed by the Architect Fumihiko Maki. The building will be located adjacent to the Wiesner building at the corner of Ames and Amherst Streets. The project design development with construction currently scheduled to begin in summer of 2002 on the site of the existing building, E10.

A major emphasis of new campus construction has been on housing for undergraduate and graduate students. Construction progressed on the new undergraduate residence on Vassar Street designed by architect Steven Holl. The dormitory, named Simmons Hall, will house 350 undergraduates. This added capacity makes it possible to assign on-campus housing to all incoming freshmen. Construction is scheduled to conclude in August 2002.

Construction was almost complete in AY2001 on the new graduate residence, 224 Albany Street (Building NW30). This facility will house 120 graduate students and will be ready for occupation in August 2001. Construction also began on the new graduate residence on the corner of Sydney and Pacific Streets. The residence will house over 700 graduate students and also is scheduled for completion in fall 2002.

Construction also began on the Albert and Barrie Zesiger Sports and Fitness Center as part of the athletic complex. The Zesiger Center will house an olympic-sized swimming pool, diving facilities, and a fitness center. It is scheduled for completion in August 2002.

Program developments, site planning and preliminary design work also have begun on the Brain and Cognitive Science Center, which will house the McGovern Institute for Brain Research, the Center for Learning and Memory and Department of Brain and Cognitive Science. It is anticipated that this center will have approximately 200,000 net assignable square feet and will be an integrated facility for neuroscience research on campus. Construction is scheduled to begin in spring of 2002 with completion in 2005.

The process for site selection and for establishing the program for a new facility for the Sloan School of Management also was begun in the fall of 2000 working with the architectural firm of Moore, Ruble and Yudell. The report of their findings is expected in late summer of 2001. The establishment of the program and site will follow after this report.

Planning for these projects has been greatly aided by the work of the Olin Partnership on the creation of a framework for the development of the MIT campus. This process began with a charette in 1999 and will be completed in fall 2001.

FACULTY AND ACADEMIC PROGRAMS

At the end of AY2001, 14 faculty retired from MIT.

Faculty recruitment continued at a vigorous level. In AY2001, 44 faculty were hired at untenured ranks and nine tenured faculty were recruited. Of these (tenured and untenured) 12 are women and 10 are minorities. During 2001, 25 MIT faculty were awarded tenure within MIT. Of these, three were women. The recruitment of minority faculty remains extremely challenging and will be the focus of an intense organization effort in AY2002.

MIT continued its commitment to enhancing the diversity of the teaching staff of the Institute through the Dr. Martin Luther King, Jr. Visiting Professor Program. There were six visiting faculty sponsored by this program during the academic year.

Renewed emphasis on the importance of improving the gender and racial diversity of the faculty began with the formation of the Council on Faculty Diversity in the fall of 2001. The council is co-chaired by Professor Nancy Hopkins, of the Department of Biology, Chancellor Phil Clay, and Provost Robert Brown and includes faculty and administrative leaders from the five schools of MIT. The council's mission is to work with the faculty, departments, schools and the senior administration to help the Institute aggressively promote faculty diversity. These efforts will work to establish a sustained institutional environment that will attract a diverse faculty that reflects the students we educate. The council will work to enhance both racial and gender diversity of the faculty by considering all aspects of faculty development:

- Understanding the pipeline of women and minority students through undergraduate and graduate schools, to post-doctoral associate positions and finally to a faculty position, and designing programs and policies to enhance retention in the pipeline;
- Examining policies and processes for faculty hiring within MIT, and making recommendations on how to more effectively enhance faculty searches and recruitment of women and minorities candidates;
- Creating programs and policies that are sensitive to the need to balance an academic career with family life; and
- Establishing an open and inclusive environment for a diverse faculty that promotes involvement in leadership throughout MIT.

The council and its working groups met throughout the academic year and will bring forward several recommendations for new policies for faculty leaves and faculty searches in the fall of 2001.

Six new Margaret MacVicar Faculty Fellows were named this year in recognition of their important contributions to the quality of undergraduate education at MIT. The awardees are Mary Boyce, Anne Mayes, David Mindell, Heidi Nepf, Janet Sonenberg, and J. Kim Vandiver.

The Presidential Graduate Fellowship program became fully operational in AY2001 with the awarding of 149.5 fellowships across all MIT academic departments. In addition, 50 new graduate students were awarded Walter A. Rosenblith Graduate Fellowships, in what was the final year of a three-year commitment. While the Rosenblith Fellowships will be eliminated in AY2002, an increased emphasis will be placed on the Presidential Graduate Fellowships. Fundraising efforts are in place to increase these resources ever further.

For new graduate students entering MIT in fall 2001, 167.5 students will be designated as Presidential Graduate Fellows. These fellowships are distributed as follows, and include fellowships named for several individual and corporate donors—Robert T. Haslam (Chemistry and Chemical Engineering), William M. Layson (Physics), Akamai (Mathematics and EECS), and Praecis (Biology):

Architecture and Planning	12.5
Engineering	56
Humanities	20
Sloan School	15
Science	57
VP Research	7
Total	167.5

In addition, five students hold Provost's Women and Minority Fellowships (one in each school) and five minority graduate students hold Norman B. Leventhal Presidential Graduate Fellowships (three in Engineering and two in Science). A Society of Presidential Fellows has been formed and will host several events during the academic year to bring this entire group of outstanding young scholars together.

FINANCES

FY2001 represented the completion of the budgetary cycle begun in 1999, and marked the second year of a new process of budget approval by the Executive Committee of the Corporation, coupled with a larger distribution of funds from the endowment. The fiscal year financial performance was on-budget, closing with a small (approximately $19M) surplus excluding funds used to established reserve accounts in several areas. This budget included funds for the renovation program, less income from graduate tuition charged to research associates, and funding of the Presidential Graduate Fellowship Program.

The performance of the FY2001 budget benefited from robust growth of the sponsored research base on campus. The research base bearing indirect costs (the MTDC base) grew 7.2 percent in FY2001. The fiscal performance also benefited from an unexpectedly robust performance of technology licensing through the Technology Licensing Office.

The financing of operations relied heavily on income generated by the Institute's endowment. The endowment began fiscal year 2001 at $6.5B up from approximately $4.3B in 2000. The final returns for FY2001 reflect a 5.3 percent decrease in market value to $6.1B. The lack of growth of the endowment will have consequences for the fiscal year 2003 budget and beyond. Planning and budgeting will continue to rely more heavily on the uses of the income from endowment. All funds accounting was implemented in FY2002 budget cycle in recognition of the increasing role of endowment income of operation of the Institute.

The MIT capital campaign, which was launched in FY2000 to raise $1.5B in endowment and expendable gifts progressed well in FY2000. The campaign, which is scheduled to run through 2004, closed this year with approximately $1.2B toward the $1.5B goal. Approximately $222M was added toward this total in FY2001.

EDUCATION

Several major new educational initiatives were moved forward in AY2001. Most notable was the continued development of a number of important educational initiatives funded from funds established by Brit and Alex d'Arbeloff. These experiments focussed on the freshman year. These projects included an experiment in residence-

based advising in McGregor House, the development of a Technology-Enhanced Active Learning format for teaching 8.02T Electromagnetism by Professor John Belcher of Physics and support of a project-oriented freshman class entitled Mars 2001 by Professor Kip Hodges of the Department of Earth, Atmospheric and Planetary Sciences. Additional support for use of information technology in education was supplied by the I-campus partnership with Microsoft.

Both of these initiatives have been organized through the MIT Council on Educational Technology (MITCET), which was established to advise the senior administration on strategic issues involving information technology and to help select major initiatives and monitor progress. The council is co-chaired by Hal Abelson, Professor of the Electrical Engineering and Computer Science Department, Robert Redwine, Professor of Physics and Dean of Undergraduate Education, and Provost Robert Brown. The MITCET also concluded a year long study of the potential for information technology to radically impact on-campus education and access the role of MIT in education of a wider group of students using distance education technology. The strategic working group of the MITCET involved in the study included faculty and staff from across MIT and effective organizational support by McKinsey & Company and Booz, Allan and Hamilton.

MITCET recommended to the administration and the faculty that MIT establish the concept of OpenCourseWare@MIT (OCW) as a web site for all MIT subjects that includes the course content (syllabus, lecture and recitation notes, assignments and solutions) for essentially all MIT subjects and that this website be opened to everyone outside of MIT. The OCW concept was supported by the faculty and endorsed by the administration. Initial support for OCW has been found from the Andrew W. Mellon Foundation and the William and Flora Hewlett Foundation. The organization of OCW will commence in the next academic year.

The organization of content creation and transmission resources with MIT has occurred simultaneously with the deliberations of the MITCET. In AY2001, the Educational Media Creation Center (EMCC) began a project to develop a software platform for MIT web sites. This project, referred to the Open Knowledge Initiative (OKI) is supported by the Andrew W. Mellon Foundation and by a consortium of universities including Stanford University, Dartmouth College and the University of Pennsylvania. A beta-version of the software platform (Stellar) was released for internal use within MIT in July 2001. Finally, the MIT Video Services were combined with EMCC to create a single content creation and transmission service center at MIT, now known as Academic Media Production Services (AMPS) under the direction of Dr. Vijay Kumar, Assistant Provost and Director of Academic Computing.

MIT continued to develop distance education initiatives as Institution-to-Institution partnerships. In the fall of 2000, the Singapore/MIT Alliance (SMA), the partnership between MIT and the two major universities in Singapore, National University of Singapore and Nanyang Technological University, expanded to include three masters and doctoral level programs. These programs are in advanced materials, high performance computing, and manufacturing. The programs are co-taught by MIT and Singapore faculty, with most of the MIT teaching being delivered by a combination of synchronous and asynchronous communications technology. The SMA program was established under the leadership of the MIT co-Director, Professor Merton Flemings of the Department of Material Science and Engineering. Professor Flemings retired at the end of AY2001 and was replaced as Director of SMA by Professor Anthony Patera of the Mechanical Engineering Department who had served as Associate Director of the SMA Program.

The programs for the collaboration between MIT and Cambridge University of England called the Cambridge-MIT Institute (CMI) continued to develop. Nine MIT undergraduates attended Cambridge University as the first part of a pilot program for the undergraduate student exchange.

Several new graduate degree programs were approved by the MIT Faculty in this academic year. Very notable is the new Master's program in Science Writing supported by the Writing Program in the School of Humanities, Arts, and Social Sciences. The program is a two-year curriculum designed for journalist and writers interested in science and technology and plays heavily on the emphasis of the Institute.

RESEARCH

MIT remains the preeminent research university combining world-leading research across a spectrum of disciplines with intense undergraduate and graduate education. Efforts in FY1999 have continued to focus on securing increased federal support of research and increasing research support from corporations, foundations and

international sources to diversify the support of our programs. These efforts began to impact the research volume of MIT in FY2001.

There was a healthy increase in sponsored research on campus, which was up 6.1 percent to $407.4 million in FY2001 from $384.0 million in FY2000. More importantly, the portion of this research volume bearing Financial and Administrative (F&A) Costs rose 7.2 percent in FY2001 to $201.2 million. The Federal government continued to dominate this budget, accounting for approximately $298.9 million or 73 percent. However, non-government support rose to $108.5 million or 27 percent. In fact, industrial support was $80.9 million and exceeded support from the Department of Defense for the first time in memory. The Lincoln Laboratory research volume in FY2001 was $348.5 million, down slightly from FY2000 at $348.3 million.

Strong growth in research volume was seen in new areas of emphasis at MIT, including neuroscience, through both the Department of Brain and Cognitive Science and the Center for Learning and Memory and at the interface between biology and engineering, especially in the Division of Bioengineering and Environmental Health (BEH).

This report marks the completion of my third year as provost.

Robert A. Brown

CENTER FOR ADVANCED EDUCATIONAL SERVICES

The Center for Advanced Educational Services (CAES) is the hub for MIT's efforts in distance learning, technology-enabled education, media production and delivery, and in non-degree lifelong learning—both on and off campus. The mission of CAES, encompassing education, research, and service, is:

- To design and conduct significant experiments in technology-enabled learning, using pedagogical models made feasible by the new technologies;
- To provide a wide range of technical multimedia and video services to the broader MIT community;
- To create and distribute MIT educational offerings within MIT and worldwide, often using technologies facilitating synchronous and asynchronous distance learning;
- To provide lifelong learning opportunities to practicing engineers and managers, both on and off-campus; and
- To undertake research and development in the application of computing and communication technologies directed toward the goal of improving the effectiveness and productivity of learning and teaching.

CAES has assembled under its "umbrella" six operating units that harness the talents of faculty and staff in technology-enabled education, media production and delivery, and lifelong learning. This allows CAES to undertake complex multifaceted projects requiring talent and technology from several of its units at one time, usually under the guidance of a full time project manager. CAES is structured as a holding company of individually managed operational units and interacts with schools, departments, centers, and laboratories Institute-wide. CAES is an integral player in the delivery of educational content with various MIT partners as described below.

Our two academic units are the Advanced Study Program (ASP)—created in the early 1960's—and the Professional Institute (PI), begun in 1949. The ASP, led by Ted Korelitz, serves domestic and foreign students who wish to further their education, usually after receiving their undergraduate degree, but for whom matriculating towards a Masters or Ph.D. is not immediately envisioned. Academic credit and a certificate are given to those completing MIT courses on-campus and via distance learning. The PI offers a non-credit continuing education curriculum of 50–60 three to five day programs each summer in the areas of Computer Sciences, Systems, Design, Materials, Control, Biotechnology, and Management. For the past three years it has also offered a smaller Winter Session.

Our research and development unit is the Center for Educational Computing Initiatives. CECI, headed by Professor Steven Lerman, advances the state-of-the-art and state-of-the-practice use of computation and communication technologies for learning and teaching. Founded in 1991, it joined CAES in 1995.

There are three units that create, deliver, and maintain various multimedia content. MIT Video Productions (MVP) provides a broad range of video recording and editing services. MVP, directed by Lawrence Gallagher, maintains and operates broadcast, post-editing, video-server and web-streaming technologies in our newly created electronic classrooms. The Educational Media Creation Center (EMCC), launched in the fall of 1999, focuses on production of web-based interactive courseware and architecture. EMCC is administratively housed in CAES and is a joint effort

in conjunction with Academic Computing. Dr. Vijay Kumar, Director of Academic Computing, serves with Professor Richard C. Larson as Co-Director of EMCC. Lastly, digitization and compression, Internet2, and video-server retrieval of any archived programming, is managed by the Streaming Media and Compression Services (SMCS). SMCS, directed by David Mycue, is now fully operational and works in parallel with MVP and EMCC.

CAES educational offerings have benefited learners of all ages. These include K–12 learners who download world-wide news from our web-site video archives, on-campus students who are beginning to see the fruits of our labors in on-campus technology-enabled learning, and lifelong learners who take MIT subjects and programs either on-campus or via distance learning.

Hiring of new personnel, particularly in the three production facilities, has escalated this past year. Processes to expedite and coordinate delivery between and among the three have evolved. There is a need for increased alignment and coordination between multiple agencies that will be necessary to deliver services coherently and efficiently to the expanding universe of academic initiatives. A planned restructuring of the production units is expected to be a constructive step in this direction.

ACCOMPLISHMENTS

Academic Programs

Professional Institute (PI) had 1,025 registrants in 41 summer session programs, and 80 registrants in six winter session programs. The summer session increased by 15 percent over the 1999 program while the winter session saw a 30 percent decrease due in large part to the harsh New England winter. It appears the concept of an on campus synchronous winter session may not be viable. Net revenues from these sessions were distributed to faculty, guest speakers, departments and the Institute. Eighty percent of PI's students are employed in industrial and non-profit institutions, and demographically 80 percent are U.S. or Canada based and 20 percent arriving from other parts of the world.

The spring term marked the introduction by the Advanced Study Program (ASP) of the System Dynamics Advanced Topics, thus completing the series of four subjects in Systems Dynamics. In addition to Advanced Topics, the others include: Strategy Dynamics; Advanced Technology; and Project Dynamics. The ASP had a 10 percent growth in revenue from its on campus programs. The total number of registered students for its off campus programs increased from 135 to 167. CAES administrative staff continued to collaborate with the Bursar's Office and the Registrar's Office to streamline the ASP tuition transfer process.

Research Programs

The Center for Educational Computing Initiative (CECI) focuses on advanced technologies emerging for educational uses, and evaluates their effectiveness. CECI shares its findings and recommendations regarding new technologies in education through published research reports. Another key part of CECI's mission is to collaborate with other CAES units to create new educational products and services. Some of CECI's projects are as follows:

The Physics Interactive Video Tutor (PIVoT), is a video-rich interactive web-based learning environment to augment the teaching of Introductory Newtonian Physics. It was completed in the summer of 2000 and released last fall to faculty and students at MIT, Wellesley, and Renssleaer Polytechnic Institute. The results of a controlled experiment conducted at RPI revealed that students in the experimental group that used PIVoT showed a stronger increase in comprehension of physics concepts than students in the control group, as indicated by scores on pre- and post-tests.

PIVoT individualizes each user's experience by providing customized tutorial information. The latest implementation of the Personal Tutor is included in the current release of PIVoT (http://curricula2.mit.edu/pivot/), which is being used during the summer of 2001 by the 80 high school students enrolled in MIT's MITE^{2}S program.

The second funded implementation of the PIVoT technology is Masters' Voices, a Web-based tutor project sponsored by the Ford-MIT Alliance. The centerpiece of this project is nine hours of videotaped interviews with senior Ford brake system engineers, in which we attempt to elicit and capture their unique experiences and craft knowledge learned over many years. The goal of the Masters' Voices Web tutor is to help preempt costly brake system design and manufacturing errors by imparting the valuable knowledge of master engineers to younger engineers. The finished prototype web site, which focuses on braking systems, was demonstrated to education and

training leaders at Ford in June 2001. CAES/CECI is pursuing additional funding from Ford to further the development of this web-based tutor, with the goal of producing one complete module, as well as authoring tools that Ford can use to create additional modules. The completed Masters' Voices site will be distributed internally at Ford through the Ford Learning Network Web environment.

CECI is also the home for Professor John Belcher's Technology Enabled Active Learning (TEAL) project that will implement an entirely new version of 8.02 this coming fall. The TEAL project is the single largest educational initiative currently ongoing at MIT. We have developed a prototype for a reform of physics education at MIT which is designed to help students develop much better intuition about, and conceptual models of, physical phenomena. This reform is centered on an "active learning" approach—that is, a highly collaborative, hands-on environment, with extensive use of desktop experiments and educational technology. The TEAL project is funded by the d'Arbeloff Fund, the Microsoft-MIT Program, and the School of Science. Previous funding for the early work on TEAL was provided by the National Science Foundation.

Other projects include the following:

The iCampus Project is a collaborative initiative of MIT and Microsoft Research to conduct research and create new technologies that will set the pace for university education in the next five to ten years.

Shakespeare Electronic Archive is an electronic environment for teaching and research on the works of William Shakespeare.

Bringing History Home is a web site that uses technology, interactive narrative and the resources of history museums to engage students in learning about the past.

The Virtual Screening Room, a fully interactive multimedia "textbook" that allows the user to read about and view actual film clips simultaneously.

The Jewish Women's Archive is an on line historical record of Jewish women's lives, their impact on Jewish culture, and their active participation in society at large.

Database Visualization in 3D is a fusion of Java, database and VRML technologies to design applications for the visualization of information stored in databases.

Operacion Futuro is a multimedia application designed to assist in the teaching of intermediate Spanish

Charactermaker is a Java-based program to create interactive characters that carry on a conversation by scanning typed input for keywords, and replying with sentences associated with those key words.

Production Units

MIT Video Productions

During fall 2000, MIT Video Productions (MVP) delivered Distance Education Courses in support of the SMA and SDM programs from Room 1-390. Utilizing state of the art technology all video, audio, and control signal processing were done from 1800 feet away via fiber in the CAES Distance Education Central Control Facility in Room 9-427. In addition, other architectural changes were made to the room based on our experience from three years use of the Triad facility for technology-enabled course delivery. This new approach to distance education delivery will result in significant savings in technical support, hardware and connectivity expenses. During the year, MVP worked on the retrofit of two additional classrooms to this centralized distribution facility. When this facility is fully built the plan is to connect approximately 15 classrooms throughout the Institute

MVP deployed its portable recording studio to several locations throughout the Institute to videotape and/or broadcast a variety of conferences, seminars, and special events. These included the HASS 50th Anniversary Celebration, Commencement, Enterprise Forum Seminar Series, the 6.270 and 2.007 contests, and Tech Day.

In FY2001 MVP purchased three Tandberg 600 videoconferencing CODECs. We upgraded our videoconferencing capability in the Linc Room, the Ford room, and in Room 1-390. MVP also significantly upgraded the audio system in the Linc room during January 2001.

Educational Media Creation Center

In its second year of operation, the Educational Media Creation Center (EMCC) continued to make progress in addressing its mission to support the production of sustainable, qualified media and Web/Internet based educational materials for MIT faculty and academic programs. During the past year, EMCC's efforts have been directed toward a mix of internal and external institutional initiatives, including, notably: the Singapore-MIT Alliance (SMA); various iCampus funded educational innovation projects (I-Fluids, Unified Engineering); PBS courses; and two projects for Pfizer—Richard C. Larson Principal Investigator and Dr. Robert Rubin clinical specialist—Good Clinical Practices and Fungal Infections. There has also been a series of smaller projects and operations, such as support for the Museum Loan Network, *MIT World* and the CAES web site. The SMA engagement has been extensive and has included direct support to faculty for their asynchronous on-line educational needs and maintenance of the SMA web site.

In the past year, the EMCC has directed attention and effort toward organization development (team orientation), project orientation and modern project management practices. Regular weekly core team meetings and reporting have been supplemented with such initiatives as regular Tech Lunches where experts, both on staff and from other areas, can share their knowledge. A focus of considerable effort over the last year has been design and development of Stellar, a software system that provides MIT with the basis for an open framework, scalable and extensible learning management system that can be used across the Institute. The production prototype of Stellar, targeted for SMA was developed on time and received favorable reviews by independent consultants employed by SMA. The Stellar work will continue during the next year with deployment to various academic programs and alignment with the specifications of the Open Knowledge Initiative project.

A related focus at EMCC has been on developing sustainable, extensible tools that can be reused across the smaller web sites that the EMCC often develops. This effort has resulted in a library of useful tools, including registration, form handling, and similar generic tools that can be applied in various web sites mostly by configuration, as opposed to programming. EMCC also provides orientation to educational multimedia and demonstration of applications through the New Media Center facility.

CAES completed renovations on the second floor to house the EMCC with public, private and work areas for students, staff, temporary workers and faculty interaction. The CAES Administrative areas also benefited from this space renovation.

Streaming Media and Compression Services

In its third year of operation, Streaming Media and Compression Services (SMCS) continued to support the efficient and high-quality production of cutting edge rich media for MIT programs, including distribution via Internet2, the commodity internet, and CD. During the past year, SMCS's work includes: the Singapore-MIT Alliance (SMA); an advanced in-class presentation project with Professor Staelin's course 6.661 Receivers, Antennas and Signals; *MIT World*; the PIVoT project; and the continuing work with Ford Motor Company; webcasting for multiple MIT events, such as Commencement, the MIT 50K contest, the MIT E-Business Awards, 2.007, etc.; PBS courses; and two projects for Pfizer—Good Clinical Practices and Fungal Infections.

Smaller projects and operations include support for the System Dynamics and other distance education courses offered through the ASP program, special streaming video tutorials for 6.002 with Professor Paul Gray and CECI's Jewish Women's Archive Project. The SMA project is the most resource-intense, entailing support for Internet2 based videoconferencing, physical infrastructure renovations, and development of new systems for asynchronous access to course materials—all of which require coordination with Singaporean staff to operate smoothly.

In the past year, internal work has been geared toward two goals. Similar to the other production facilities, there has been an effort in SMCS to systematize the process to provide a more scaleable and efficient operating model. To this end, an automated process of capture and a complementary physical renovation have been researched and designed, with implementation taking place over the summer. Staffing issues comprise the other significant area of activity. SMCS projects have enjoyed substantial growth and positive feedback over the past year. While there have been

growing pains, the knowledge gleaned from the process will make the necessary future expansion manageable. It is clear that growth will continue, not merely at its current rate, but at an even brisker pace.

MIT World

MIT CAES is creating a new on-demand video service, soon to be a 24/7 TV station, *MIT World*. Each semester, on the MIT campus, scores of internal and external speakers give public talks, seminars, colloquia, and other presentations. These talks are substantive, often newsworthy, and are of great interest to a much broader community, including MIT's corporate partners and alumni, on-campus faculty, staff, students, and members of the public. A selection of these public events will be professionally videotaped, digitized, and ported into *MIT World*. The choice of videotaped lectures will be chosen by CAES, working closely with the Alumni Association, Industrial Liaison Program and other stakeholders appointed by the Provost. The streaming videos will be accessible both on demand and via a TV station continuous broadcasting mode. *MIT World* brings the intellectual content of campus activities to anyone, anywhere in the world. On its web site, lectures so far include: Ford/MIT Nobel Laureate Lectures by Professors Franco Modigliani, Paul Samuelson and Robert Solow; Lecture on the Human Genome Project by Professor Eric Lander, Director of the Whitehead Institute; 2001 Howard Hughes Lecture by Professor David Baltimore, President of Caltech; the Wallenberg Lecture on Sustainability and the Environment at MIT by Leif Johansson, President and CEO of Volvo; Technology and Culure Forum lecture by Professor Noam Chomsky; Ford/MIT Nobel Laureate Lecture by Professor Charles Townes; and the Pappalardo Distinguished Lecture in Physics by Professor Frank Wilczek, Herman Feshbach Professor of Physics, MIT.

PBS the Business Technology Network: CAES introduced new major programming for PBS the Business Technology Network: EBusiness 2001: Predictions and Projections, co-taught by Thomas Malone, Stuart Madnick, Chrysanthos Dellarocas, Steven Lerman and Richard Larson; Logistics taught by Lawrence Wein; and Integrated Supply Chain Management taught by Jeremy Shapiro. Certificates of completion for courses offered through PBS/NTUC were issued to nearly 1,000 learners during this reporting period.

During last year, our alliance with PBS/NTUC shifted when NTUC changed its name to Stratys Learning Solutions in November 2000 to reflect its broader scope of e-learning and distance-learning strategies. The MIT programming (still shown under the brand PBS the Business and Technology Network) experienced a dramatic shift in interest in asynchronous web-based delivery and CD ROM format rather than live synchronous satellite delivery. Course scheduling now allows for enrollment throughout the year. This enhancement provided flexibility for distance students and was a major contributing factor for increased enrollments and revenue.

Visitors

In 2000, CAES hosted many groups and individual meetings during the year, giving presentations on distance learning and technology-enabled education at MIT. These included groups from the following companies and institutions: Novartis, Integris, Athenium, Harcourt University, Japan Audio Visual Education Association, Harvard Medical International, the War College, US Navy, Objectivo (Brazil); Universities of Witwatersrand and Pretoria (South Africa); Waseda University (Japan); University of Dublin, University of Cambridge (UK). Presentations were given to delegations from the Parliament of Finland and the VaNTH Conference sponsored by the HST program.

The first part of 2001 saw continued interest in the work of CAES by visitors from abroad. These included: educators from the University of Southern Denmark; Petronas (Malaysia) oil company; Lyons Business School; an Eisenhower Exchange Scholar from Argentina; a German delegation of university professors and members of the Federal Ministry of Education, and British Telecom. An updated information packet has been produced and the web site now includes a "What's New" section featuring the latest activities at the Center. CAES joined the U.S. Distance Learning Association to promote the development and application of distance learning for education and training.

IMPACT OF INSTITUTE-WIDE RECOMMENDATIONS

CAES faculty and staff, in collaboration with other faculty and staff throughout the Institute, made significant contributions to a major recommendation by the MIT Council on Educational Technology (MITCET). The concept was named OpenCourseWare@mit.edu. A revolutionary notion of OpenCourseware@MIT could radically alter the entire lifelong learning and distance learning field and MIT's role in it. The proposal resulted in $11 million in initial funding.

CAES has launched additional initiatives in keeping with the goals of the recommendations from the MITCET report issued in the Fall of 2000. In its executive summary, the report recommended a financially viable lifelong learning program called "Knowledge Updates" (KUs: short, focused, learning modules) with significant on-campus and off-campus benefits. A CAES business plan for KUs is in development.

NEW INTERNATIONAL PARTNERS

Many of the CAES operating units have already reported on their work in support of the SMA and SDM course delivery. In addition, CAES is in discussion with the Cambridge/MIT Alliance for similar course delivery. There are ongoing discussions with several new international partners, especially in Asia and Africa, for shared efforts including delivery of educational content and collaborative research in educational technologies.

ADMINISTRATIVE CHANGES AND COLLABORATIONS

September 1, 2000 marked the 5th anniversary of the reorganized CAES. June 30, 2001 will also mark the start of another important shift as CAES is reorganized again. A new educational technology organization, the Academic Media Production Services (AMPS) will be announced during the summer of 2001. Three CAES production facilities will be at the nucleus of AMPS: EMCC, MVP, and SMCS. Together they will operate as a separate administrative unit reporting to the Provost and led by Assistant Provost, V. Kumar as Director.

Cost analysis and pricing structure of the three production units, services, and facilities were undertaken and will be implemented in FY2002.

A new visitors policy to meet the growing demand for presentations to visiting groups was put in place in April 2001. In 2001, we received over 150 requests for a presentation or meeting with members of the center's staff.

CAES serves all five schools at MIT, and currently has major projects and on-going relationships with four of them. Collaborations are currently active with the Physics Department, the School of Humanities, Arts, and Social Sciences, the Singapore MIT Alliance, the Systems Design and Management Program and the Department of Civil and Environmental Engineering.

CECI and EMCC staff are directly involved in the Open Knowledge Initiative (OKI), mostly in providing expertise in the architectural design of the software.

Professor Richard Larson served on the Peer Review Committee of Section 8 of the National Academy of Engineering, Industrial, Manufacturing and Operational Systems Engineering (IMOSE), where he is Vice Chair, and Chair of the Membership Committee.

Professor Steven Lerman, Laura Koller, and several other MIT faculty and staff were deeply involved in the conceptual development of MIT OpenCourseWare, (OCW), including the successful proposal to the Mellon and Hewlett Foundations that secured the commitment of $11 million for the first 27 months of the program. Professor Lerman is now serving as the Chair of the OCW Interim Management Board and in 2000–2001 served in his second year as Faculty Chair. Vijay Kumar, Richard Larson and Steve Lerman served as members of MITCET. MITCET's first two major recommendations were MIT OpenCourseWare and Knowledge Updates.

MVP, EMCC, SMCS, and CECI are delivery partners for SDM and SMA distance education programs.

MAJOR DONATIONS AND BEQUESTS, GRANTS, FINANCIAL ASSISTANCE, FELLOWSHIPS, INTERNSHIPS

A portion of the Lord Foundation funds awarded to CAES last year was directed toward the first phase of creating video tutor materials for Professor Paul Gray. Professor Gray created content for a web-based video tutor to support the course he teaches, 6.002 Introduction to Circuits and Electronics. He worked with MIT Video Productions to produce a series of video help sessions, much like those produced by Professor Walter Lewin for the PIVoT project. A two-camera studio setup showed Professor Gray talking directly to viewers and explaining circuit theory concepts with drawing diagrams and equations. The help sessions were digitized in both high-bandwidth and low-bandwidth versions and posted on a freely accessible web page (http://Web.mit.edu/6.002/www/current/videos/) for students to review at their own pace.

Lounsbery Foundation funds were secured for the final modifications to 8.01 PIVoT project. The results of the student evaluation conducted last fall, suggested modifications that would improve the effectiveness of the PIVoT site and consequently of future web tutors based on the same technology.

Two major projects with Pfizer are underway entitled Good Clinical Practice and Fungal Infections. The scope of the first project is to develop an interactive web-based course on Good Practices in Clinical Research to physicians, initially in Latin America, and eventually worldwide. The course will describe the principles of Good Clinical Practice and will cover a wide range of topics that include: introduction to clinical research, ethical considerations, applied statistics, planning and implementation of clinical trials, conducting clinical trials, and the future of clinical research. The content will include 25 lectures, and three interactive exercises and will have lectures and slides in English and audio-only lectures and slides in Spanish. The second project, Fungal Infections, will have seven one-hour lectures and supporting x-rays, slides and pathology, and 15 interactive case studies. The first version will be in English with multi-lingual versions in the future.

MIT CAES is involved in the design and production of these projects since they are pushing the state of the art in e-learning and will be available without charge to those in need of its content. In developing areas, this effort should help to reduce any growing "digital divide."

CAES signed an agreement with College Coach, a leading provider of employer-sponsored college counseling services. Called the Virtual Learning Center (VLC), this tool will guide families through the most important steps towards completing the college admissions process. MIT faculty and staff members will have free access to this service for one year following completion of the project.

The PIVoT team continues to collaborate with WGBH's National Center for Accessible Media (NCAM) to research web accessibility for deaf and blind users. WGBH also receives funds through the National Science Foundation and Mitsubishi Electric America Foundation. This year's research activities have focused on digital video captions for deaf users, video descriptions for blind users, alternative modes for presentation of equations and graphics, and other web accessibility issues. CAES visited local universities to discuss PIVoT as a supplement to their pedagogy and planned to present the platform at the annual meeting of the American Association of Physics Teachers.

Professor Steven Lerman, Dr. Judson Hudson, and Dr. George Kocur received a d'Arbeloff Fund grant for the migration of Subject 1.00/1.001 to a studio format. This grant will fund the transformation of the course from a lecture/recitation presentation to a series of guided, "hands-on" learning experiences that involves small groups of students working under with faculty and teaching assistant mentorship. The first pilot trials will be introduced in approximately six units in 1.00/1.001 this coming fall. Further refinement of the materials being created will be done in the spring semester, with the goal of complete conversion of the course in fall 2002.

FUTURE PLANS

The academic year 2001–2002 will see the six units of CAES re-positioned for accelerated growth and service to the MIT Community. The three production units, to be placed on an accrual method of accounting as a means of pricing services under a sustainable method to recover capital costs, will operate efficiently and effectively as services businesses within MIT under a new department called the Academic Media Production Services (AMPS). CAES will remain one of the largest customers of AMPS.

CAES has its major growth objectives rooted in two Administration-supported initiatives: *MIT World* and Knowledge Updates. A business plan is being developed for Knowledge Updates, short web-based educational offerings to be delivered asynchronously to the learner. Working with other MIT schools and departments, these offerings will be market-driven and will be an important focus of MIT's contribution to distance learning corporate training.

In addition, CAES will continue to seek partners off campus for collaborative research and development and for its life-long learning educational offerings. In these efforts, CAES seeks to add a significant international component to its activities in the years to come.

Work will continue during the next academic year to provide CAES academic services to both on campus and off campus learners. This means that portions of the programs of both the ASP and the PI will be "virtualized" and delivered to students perhaps an ocean away from MIT.

Virtual Tutors

Funding from the Lord Foundation will allow CAES to begin the production of PIVoT 8.02, a web site that will support Electricity and Magnetism. Professor Walter Lewin will teach 8.02 in spring 2002, and his lectures will be videotaped, digitized, and tagged in preparation for PIVoT 8.02. Additional funding is being sought for the development of a full-featured PIVoT 8.02 site.

CECI is currently working on a research initiative in what we are calling "near synchronous education." This includes multimedia support tools that facilitate rapid turnaround in asynchronous, student-student and student-teacher interaction.

PERSONNEL CHANGES

Appointments, Promotions, Departures, Retirements, and Leaves

Affiliated Staff from Academic Computing were available to the EMCC in a variety of roles: Michael Barker, Craig Counterman, Heather Buch, Andy Oakland, and Katie Livingston-Vale as programmers/developers; Phillip Long as a coordinator for faculty engagement and projects; and Jeffrey Merriman providing leadership and management to the Stellar and OKI efforts.

New Staff includes Mark Bessette, Joanna Binkowski, Dianne Brooks, David Constine, Mary Curtin, Edward Grady, Michael Leoncini, Elaine Mello, Shannon Rutherford, Stacy Scheingold, and Janet Wasserstein.

H. Scanlon, Todd Rautenberg, and Jay Collier left the office this year.

Brian Bermack and Robert Hawley were on leave this year.

The following people held visiting appointments: Solveig Bjoernestad, Ana Chiquito, Norman Derby, Judy Dori, Shlomo Maital, Richard Olivo, and Jesse Heines.

PAPERS PRESENTED, ARTICLES AND BOOKS PUBLISHED OR IN PROCESS

L. Koller and G. Willman: "Physics Interactive Video Tutor Helps Students Master 8.01," *I/S Newsletter,* Vol. 16, No. 1, September/October 2000, pp. 1-2.

Dr. A. Lipson, Associate Director for Educational Studies, MIT Teaching and Learning Laboratory: "A Comparative Analysis of PIVoT Use in Three Schools: MIT, RPI, Wellesley."

J.W. Belcher, and M. R. Bessette: "*Using 3D Animation in Teaching Introductory Electromagnetism, Computer Graphics,*" February 2001.

K. Delong, E. Vemulapalli, and R. Zbib: "The Use of XML Technologies for Mapping Information Between Partially Consistent Data Models;" March 2001. Federated Laboratory 5th Annual Symposium on Advanced Telecommunications/Information Distribution Research Program (ATIRP). 107-111, Proceedings.

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Melinda G. Cerny and Jesse M. Heines, 2001: "Evaluating Distance Education Across Twelve Time Zones." T.H.E. Journal 28(7):18-25

G. P. Strehle,, Distance Learning in America: "How Institutions and Corporations are Stimulating Growth," September, 2000.

M. Cerny and D. Mycue, The Singapore-MIT Alliance: "Lessons Learned in Technical Delivery," November, 2000.

R.C. Larson and G. P. Strehle: "Edu-Tech: What's a President to Do," December, 1999, revised February, 2000.

E. De Rienzo: "MIT's Experience Education," Technion Institute of Management (TIM) Times, Volume 4, Winter 2001.

Publications about CAES include:

- "The Institute at a Distance" by Christina Roache, Technology Review, July/August 2000;"
- "Interactive Physics Tutor Personalizes Help for Students," Syllabus, November 2000;
- "MIT Does Distance Learning" by Charles Conte S&VC, April 2001, http://www.scvonline.com/;
- "MIT Rockets into Learning" by Charles Conte S&VC, May 2001, http://www.scvonline.com/; and
- "MIT World and OpenCourseware at MIT" by Jennifer Kavur, Higher Learning Technology Supplement, May/June 2001

Conference Presentations

Dee Dow-Chase and Lawrence Gallagher presented "High-tech learning at MIT spawns a new classroom and production infrastructure" at the Tradeline Conference.

Professor Richard Larson presented at the following conferences this past year: NE section Syllabus, "PIVoT: A web-based supplement to a core science course" (with L. Koller); NAS panel, Workshop on the impact of IT on the future of the research university, "The impact of IT on the organization and structure"; Eastern Association of College and University Business Officers, "E-business in education"; University of Maryland, "Edu-Tech: How may it change higher education"; Eduventures, "The digital education marketplace 2001"; NE chapter of the American Society for Information Sciences, "E-learning: Myths and realities"; US House of Representatives Committee on Science, "Technology-enabled education, the Internet, distance learning and the research university"; Indiana University Plenary Speaker, "Technology-enabled education: What it can do for Operations Research"; ASPEN Forum Conference Co-Director, Forum on "The Internet and the university"; Tehran, Iran. A series of invited plenary lectures on industrial engineering and operations research, and on technology-enabled education and distance learning, Sharif University of Science and Technology, and Iran's First National Conference on Industrial Engineering.

Michael Barker and Melinda Cerny, NE section Syllabus Conference "The Singapore-MIT Alliance: Lessons Learned in Technical Delivery," David Mycue was co-author on this paper.

Professor Steven Lerman, *Educational Technology at MIT*, presented to the MIT on the Road Program, March 2001.

AWARDS AND HONORS

Craig Milanesi and David Mycue received MIT Infinite Mile Awards.

CAES Departmental Award Recipients include: Dianne Brooks, Ben Brophy, Joanne Flood, Kirky DeLong, Pam Homsy, Laura Koller, Elaine Mello, Meg Westlund, Carol Sardo, and Gayle Willman.

Outstanding Guest Speaker Award was given to Professor Richard C. Larson, the First Industrial Engineering Conference, Tehran, Iran, May 30–31, 2001, Sharif University of Technology and Iran Institute of Industrial Engineering.

CHANGES IN CURRICULUM

We strengthened our relationship with General Motors/Technology Education Program (GM/TEP) who decided to rerun the original Systems Dynamics course and to add a course in manufacturing.

FINDINGS, INVENTIONS, PRODUCTS (VIDEOS) BREAKTHROUGHS

CECI developed a plug-in module for Virage's video segmentation software that automatically detects potential segmentation points in SMA lectures that make use of electronic whiteboards. This tool is of use in subdividing SMA lectures for placement on the video server both here and in Singapore.

Richard C. Larson

CENTER FOR ARCHAEOLOGICAL MATERIALS/ CENTER FOR MATERIALS RESEARCH IN ARCHAEOLOGY AND ETHNOLOGY

The mission of the Center for Materials Research in Archaeology and Ethnology (CMRAE), a consortium of eight Boston-area educational and cultural institutions, is to advance our understanding of prehistoric and non-industrial culture through analysis of the structure and properties of materials associated with human activity. Plant and animal food remains, human skeletal material, as well as metal, ceramic, stone, bone, and fiber artifacts are the objects of study, along with the environments within which these materials were produced and used. At the Center for Archaeological Materials (CAM) at MIT, investigators concentrate on the materials processing technologies that transform natural materials into cultural objects.

At MIT, CAM is administered by the Department of Materials Science and Engineering (DMSE). DMSE established a new, undergraduate major in Archaeology and Materials, Course III-C, as well as an interdisciplinary doctoral degree program in Archaeological Materials. Both sets of curricula were reviewed by the appropriate MIT committees during the 1997–1998 academic year and were in place in 1998–1999. These are the only academic degree programs of their kind in the United States.. Jennifer Meanwell, the first student to enter the III-C program, graduated in June 2001 and won the prize awarded by DMSE for outstanding senior thesis. Her research on ceramic production in ancient Guerrero, Mexico was supervised by Professor Dorothy Hosler. Three additional undergraduate students entered Course III-C by the end of the 2000–2001 academic year.

Archaeological Science, the CMRAE/CAM undergraduate subject introduced during the 1995–1996 academic year, and offered jointly by DMSE and the Chemistry Department, continues to enjoy high popularity among students from CMRAE institutions. Eighty-three students enrolled: 67 from MIT, two from Boston University, nine from Brandeis University, three from Harvard University, and two from Wellesley College; eleven faculty members from five CMRAE institutions lectured in the subject.

DMSE admitted three students to the doctoral degree program in Archaeological Materials. This first cohort of doctoral candidates will matriculate in the fall of 2001. Jennifer Meanwell received a Presidential Fellowship from MIT. Michael Tarkanian will receive a Research Assistantship funded by a joint CMRAE-DMSE grant from the Division of Materials Research at NSF. Katherine Kershen received a Fulbright Scholarship to study archaeology and archaeological science in Turkey and will defer her matriculation to the fall of 2002

CMRAE and DMSE jointly received a grant in May 2001 from the Division of Materials Research at NSF. The three year, $750,000 award will support an MIT Summer Institute in the Materials Science of Material Culture. Professor Heather Lechtman is Principal Investigator for the project; and Professors Dorothy Hosler, Linn Hobbs, and Samuel Allen are Co-PIs. The purpose of the Summer Institute (SI) is to assist professors at liberal arts colleges in introducing materials science and engineering to their undergraduate curricula. At each two-week SI session, MIT faculty, faculty from undergraduate liberal arts institutions, and DMSE Archaeological Materials graduate students supported by the grant will consider case studies that combine materials science and engineering with social science

and humanities fields. The case study modules will include intensive laboratory exposure to the processing and testing of materials. The pedagogic aims of the modules are: to put people at the center of the materials polyhedron described by structure/properties/processing/and product, and to provide case studies exemplifying these relationships that college professors can use to present engineering science and human sciences to their students.

The SI philosophy is based on principles the PIs consider fundamental to the design of higher education in the 21st century: (that science and engineering have their origins in multiple cultural traditions which account for their richness and permanence in human endeavors; and that access to the social wealth of society lies in education that allows people to generate and interpret a wide range of data from a broad methodological base.

The CMRAE two-semester graduate subject Materials in Ancient Societies offered during the 2000–2001 academic year considered bone as an archaeological material. The fall semester focused on zooarchaeology and was taught by Dr. Richard Meadow (Harvard University). The spring semester treated human osteology and was taught by Professor Michael Gibbons (University of Massachusetts, Boston).

More information about this center can be found online at http://web.mit.edu/cmrae/cmrae_home.htm.

Heather Lechtman

COUNCIL ON PRIMARY AND SECONDARY EDUCATION

The Council on Primary and Secondary Education (CPSE) develops programs that bring the strengths of MIT to bear on the American K–12 educational system. The projects sponsored by the Council include the MIT/Wellesley Teacher Education Program, Teacher Sabbaticals, and the MIT's Educational Outreach Programs Directory. The Council's Chairman is also involved in a number of K–12 educational efforts, including the Science and Engineering Program for Teachers and its product, the New England Science Teachers, as well as a collaboration with the Association of American Universities (AAU).

MIT/WELLESLEY TEACHER EDUCATION PROGRAM

To foster the growth of a cadre of new teachers who meet MIT's standards of excellence in science and mathematics, yet appreciate the value of different ways of approaching and understanding a problem, MIT has created a joint program with Wellesley College, the Teacher Education Program (TEP). It prepares undergraduates for Massachusetts State Certification in mathematics and science at the middle and high school levels. This program, started in the fall of 1993, has now been integrated into MIT's Department of Urban Studies and Planning. Enrollment in TEP's introductory Course 11.124 has steadily increased. During this six-year period, TEP has enrolled over160 students in the initial course toward completing Massachusetts State Teacher Certification. Many of the students who have completed certification are now teaching in public middle or high schools, mostly in the Boston area. Others entering the program have been recruited by private, independent, schools, while some have gone on to become graduate students in schools of education such as Harvard, Stanford, University of California-Berkeley, and Columbia. Two students have entered the Peace Corps.

Undergraduates in the program must complete a major in the subject area in which they wish to teach. In addition, they must complete three courses at MIT and two at Wellesley; one of the latter is a seminar taken in conjunction with the required 150 hours of supervised practice teaching. Students must also complete 75 hours of supervised classroom observations.

The MIT's Class of 1952's Educational Initiatives Fund was key to launching TEP in 1993. TEP was funded from 1994–1997 by the National Science Foundation through a collaborative called Teacher Education Addressing Math and Science in Boston and Cambridge (TEAMS-BC) which included MIT, Harvard, UMASS-Boston, Wheelock College, and the Boston and Cambridge school systems. TEP is supervised by Professor Eric Klopfer. Dr. Klopfer has a B.S. in Biology from Cornell and a Ph.D. from the University of Wisconsin. He has taught full time in the Amherst Regional High School and prior to his MIT appointment served as a Lecturer in the School of Education at the University of Massachusetts. He has studied the impact of computer systems on student learning in science, math and language arts. His current research focuses on the use of educational technology in science education and is particularly interested in computer simulation as a tool in science education. More information about TEP can be found online at http://web.mit.edu/teacher-ed/www/.

The council is pleased to announce the establishment of the Joseph B. ('54) and Rita P. Scheller Career Development Professorship for Teacher Education. Professor Klopfer is the first holder of this professorship. The Scheller Professorship represents an historic milestone in the evolution of MIT's K–12 agenda.

TEACHER SABBATICALS

The Class of 1952 Educational Initiatives Fund also launched the MIT Teacher Fellows Program, which brings middle and high school teachers together with MIT faculty. Not only is this program effective in helping teachers develop new and creative ways to teach math and science, it allows MIT faculty to share their expertise in the development of K–12 math and science curricula.

Four high school teachers were on campus for year-long sabbaticals. They are Mr. Dana Dunnan of Masconomet High School (Topsfield, MA); Mr. Ken Brody of Boston Technical High School; Ms. Lynda Beck of Philips Exeter Academy of Exeter, NH and Ms. Isabel Courtney of the Greenwich Connecticut school system. Although the '52 fund contributed to the stipends of teachers in the past, the above teachers were self-supporting. Mr. Brody will return to MIT in AY2001–2002. Mr. Brody continues to serve as the Secretary of the Network of Educators in Science and Technology (NEST). Additionally, he arranged tours of MIT by NEST teachers and students. We are pleased to have precollege educators with us. Their understanding of the needs of classroom teachers is essential to the development of MIT's agenda in K–12 education.

EDUCATIONAL OUTREACH DIRECTORY

The council's *MIT's Educational Outreach Programs* has been widely circulated. Approximately 65 programs are listed; programs are either conducted on MIT's campus or have the involvement of a person from MIT's faculty, staff, or student body. The directory is now also available through the council's home page. Activities range from the *Chemistry Magic Show*, a 45-minute long road show of attention-getting chemistry experiments along with a running commentary, to the *Voyage of the MIMI,* an interdisciplinary, multimedia math and science presentation geared toward 4th–8th graders using connected educational television, software, and other instruction materials.

PROGRAMS BY THE CPSE CHAIRMAN

Since October of 1997, CPSE Chair Latanision has led a Task Force on K-16 Education, an arm of the AAU President's Committee on Undergraduate Education. The Task Force is leading an AAU-wide Implementation Plan that includes action that will accomplish the following:

- to establish on each AAU campus a Teacher Education Program that certifies disciplinary majors to teach at the precollege level and enriches the professional development of in-service teachers. (An AAU Forum on Best Practices in Teacher Education has been scheduled for the Fall of 2001 at the House of the American Academy of Arts and Sciences.);
- to establish an AAU Clearinghouse on Assessment Systems to analyze emerging state assessment systems in order to determine the possible utility of the data form such systems for admissions and placement purposes and to provide feedback to states on the relationship between these assessments and AAU universities' admission requirements; and
- to lead a national conversation including university faculty, administrators, K–12 representatives and others in order to: develop a clear statement of what research universities believe are the key knowledge and skills prospective students need, not only for college admissions but for a reflective and fulfilling life; and identify and develop as part of the national conversation a consensus on the educational research issues that AAU institutions should address. (These issues might include, for example, research to identify the best use of educational technology in the teaching and learning enterprise.)

The Clearinghouse and National Conversations are being developed with a $2.4 million grant from the Pew Charitable Trusts, which began in April 2000. Both topics are incorporated into a program now known as *Standards for Success.*

Science and Engineering Program for Teachers: Professor Latanision directs the *Science and Engineering Program for Teachers*, which shares the Council's goal of science literacy for all students. Key to a good education is an enthusiastic, knowledgeable teacher. Since 1989, this program has endeavored to give educators a unique perspective of how the basic sciences, mathematics, and engineering are integrated to meet the technological challenges and needs of commerce and society. In 2001, the program ran from 24–30 June and had 74 participants from across the United States and four countries. Once again, this program was offered on a fee-bearing basis. Every

participant covered his/her own expenses. One-third of the participants were fully supported (travel, room and board) by MIT Alumni Clubs, testimony to the concern of MIT Alumni for precollege education. NEST teachers also participated in the Star Logo Community of Learners Workshop aimed at developing useful, curriculum supporting modeling tools. The workshop was led by Professor Klopfer and supported by the Siemens Foundation.

The alumni of this program, now totaling approximately 800 people, become members of the Network of Educators in Science and Technology (NEST). This year, NEST members came to MIT's campus on June 29th for a two-day meeting to assess the program and determine future directions for the organization. The year 2001 Agenda for returning NEST alums represents a new alliance between NEST and MIT's Center for Materials Science and Engineering. CMSE Director, Michael Rubner, arranged a full day program for NEST on 29 June. The Annual Fall Retreat of NEST was held in Falmouth, MA on 10–11 November 2000.

We are very pleased to report that MIT alumnus, Johan von der Goltz has pledged a gift of $350,000 over a five year period to sustain the *Science and Engineering Program for Teachers* and NEST. For the first time, eight Siemens Scholars were identified from among the participants in the *Science and Engineering Program for Teachers.* These teachers were supported during their visit to MIT by the Siemens Foundation. In addition, the Foundation provided the resources for MIT's first Siemens Teacher Fellow: a teacher, Ms. Rebekah Ravgiala, is in residence at MIT during the summer of 2001 as a member of the research team of Professor Michael Rubner, Director of the Center for Materials Science and Engineering. The object of this effort is to make research experiences available to in-service teachers. It is my goal to have 40–50 such teachers on campus during the summer in a few years.

More information about NEST can be found online at http://web.mit.edu/nest/www/. More information about the Council on Primary and Secondary Education can be found online at http:// web.mit.edu/cpse/www/.

R.M. Latanision

OFFICE OF EDUCATIONAL OPPORTUNITY PROGRAMS

The Office of Educational Opportunity Programs was created in January of 1992 to organizationally locate the MIT/Wellesley Upward Bound Program, the MIT Educational Talent Search Program (ceased operation in FY1998), and all future programming serving low-income community youth. MIT has operated the Upward Bound Program since 1966 and began operation of the Educational Talent Search Program in September of 1991.

Upward Bound and Educational Talent Search are two of six U.S. Department of Education: Special Programs For Students From Disadvantaged Backgrounds (TRIO Programs) created under the Higher Education Act of 1965.

The goal of these programs is to provide college admission and preparatory information, academic support, advising, career information, and college and career exploration opportunities to the economically and/or educationally disadvantaged youth of Cambridge and formerly Somerville.

To a large extent, the development of both programs was influenced by the research done by psychologist Kurt Lewin and his associates. Lewin's hypothesis was that ego growth and academic performance were closely related. Moreover, he concluded that a developing ego needs to experience success in a warm and personal, structured environment for greatest development, in both a personal and social sense. Lastly, it was determined that this personal and social growth could be achieved through intervention outside of the institutions of family and school. Educational Talent Search and Upward Bound, through their year-round academic support and advising, and cultural experiences represent just such interventions.

MIT/WELLESLEY UPWARD BOUND

The MIT/Wellesley Upward Bound Program is a year-round, co-educational, multi-cultural, college preparatory program for high school youth who reside or attend school in Cambridge. Currently in its 34th year, the Program serves 70 academically promising young men and women from disadvantaged backgrounds. The goal of Upward Bound is twofold: to motivate client high school youth such that they persist on to post-secondary education; and, at the same time, and to provide them with the fundamental skills necessary for success at the collegiate level.

The following is an overview of the program's operational phases:

The six-week summer program, conducted in residence at Wellesley College, is designed to provide the participants with a rigorous academic experience. Classes are taught by experienced high school teachers, and graduate and undergraduate students from MIT, Wellesley College, and other local colleges and universities. Each participant is required to enroll in a Mathematics course, an English course and an elective course: Social Studies, Science, or World Languages. (Additionally, due to an agreement with the Cambridge Public Schools, students may receive summer school credit for up to two failed major courses taken during the preceding school year.)

The academic year program located at MIT, plays an equally important role in the educational development of participants. Building upon the motivation and enthusiasm developed during the summer, the academic year program is designed to assist and support the participant while in school. To accomplish this task, the following programs, staffed primarily by MIT and Wellesley College students when appropriate, have been developed. (We continually strive to maintain MIT and Wellesley College students' participation through our continued involvement as a pre-practicum site for the Wellesley College Teacher Certification Program and through various outreach efforts.)

- The Upward Bound office is open for study, on a drop-in basis, four days a week. Tutors are available to assist participants with homework problems in addition to meeting individuals and/or small groups for specific content area tutorials.
- The program offers workshops monthly to address more specialized participant needs (e.g., SAT Preparation, Computers, Study Skills Development, Time Management, Job Readiness Skills, etc.).
- Also, in an effort to help participants cope with the myriad of problems; academic, social, family, etc., the Program offers support in the areas of guidance, college, career and personal adjustment. The college advising component includes campus visits to many of the local colleges and universities and attendance at two local college fairs, while the career advising component offers exposure to career options through our Speaker Series Program as well as through research on the internet.
- The program provides numerous field trips that have as their purpose, the intellectual, social and cultural development of the participants. Such trips included; the Museum of Science, the Omni Theater, dramatic productions, Museum of Fine Arts, skiing, bowling, and roller-skating.

One hundred percent of the program's graduating seniors have been accepted into postsecondary education institutions. The program's Class of 2001 has enrolled in the following colleges and universities; Clark Atlanta University, Johnson and Wales University, Salem State College, Marymount College, Michigan State University, Morris Brown College, Norfolk State University, South Carolina State University and Suffolk University.

Ronald S. Crichlow, Evette M. Layne

McGOVERN INSTITUTE FOR BRAIN RESEARCH

On 28 February, 2001, Patrick and Lore McGovern and Charles Vest signed an agreement to create the McGovern Institute for Brain Research at MIT with a gift expected to total $350 million over the next 20 years. The McGovern Institute's mission is to investigate the basis of human higher brain function, using a multi-disciplinary approach that includes applied physics, engineering, computer science, computational neuroscience and cognitive psychology in addition to biological sciences. Phillip Sharp is the founding Director of the Institute. The Institute will be housed in a new state-of-the-art building on the MIT campus which will be available at the end of 2004 and currently occupies interim space until the building is finished.

The McGovern Institute will sponsor cutting-edge research concerning how the brain acquires information and assesses its significance, how information is stored in memory, and how information is processed and organized within the brain to form decisions, and to communicate with others. McGovern scientists will apply a wide range of experimental approaches to the study of the brain, including neurophysiological recording, computational analysis, neuroimaging, and genetic and molecular techniques. Amidst this diversity of disciplinary origins and technical approaches, the intellectual coherence of the Institute will derive from a common commitment of the McGovern faculty to understand higher brain function. McGovern faculty will hold primary appointments in several departments at MIT, including Brain and Cognitive Sciences, Biology, and Electrical Engineering and Computer Science. When fully developed with its own building, the Institute will have 16 faculty members and associated research staff.

The research programs of the McGovern Institute initially emphasize three rapidly advancing areas which are central to understanding the brain and its functions: experimental and computational investigations of integrated systems in animals with complex behavior, development of high spatial and temporal imaging of the brain, and genetic analysis of behavior and neurobiological systems. The McGovern Institute provides a focus for synergistic interactions among various research communities at MIT, with the overarching aim of achieving a deep understanding of the brain and its role in mediating mental function.

In addition to Professor Sharp, the following appointments have been made to the McGovern Institute.

Emilio Bizzi is the Eugene McDermott Professor in the Brain Sciences and Human Behavior in the Department of Brain and Cognitive Sciences. Dr. Bizzi's work focuses on how the central nervous system translates brain messages signaling motor intent into muscle activation. He recently discovered that the spinal cord contains a map of limb postures that is key to this transformation.

Martha Constantine-Paton is a Professor of Biology in the Department of Biology, with a joint appointment in the Department of Brain and Cognitive Sciences. She studies activity and brain development, glutamate receptor regulation, and sensory physiology of vision and audition. Professor Constantine-Paton's recent work has focused on the role of the N-methyl-D-asparate subtype of glutamate receptor (NMDAR) in activity-dependent connections between neurons. It is possible that upregulation of this receptor could be important in recovery from brain damage. She studies these processes in rodent and frog systems. Ann Graybiel is the Walter A. Rosenblith Professor of Neuroscience in the Department of Brain and Cognitive Sciences. She studies the neurophysiology of a brain region that is implicated in the control of movement and cognition, as well as in our ability to learn habits. Disorders in this region have been implicated in Parkinson's and Huntington's diseases, and in neuropsychiatric disorders such as Tourette's syndrome, obsessive-compulsive disorder and addiction.

H. Robert Horvitz is the David Koch Professor of Biology in the Department of Biology and an Investigator of the Howard Hughes Medical Institute. Professor Horvitz is studying how the nervous system controls behavior using genetics, laser microbeam ablation and pharmacology. He recently discovered that the animal's serotonergic nervous system plays a central role in its response to experience. This has led to the identification of a serotonin-uptake transporter similar to the target of the human antidepressants(e.g. Prozac). He also was a major figure in the collaboration that discovered the identity of a human gene responsible for the inherited form of amyotropic lateral sclerosis (ALS or Lou Gehrig's disease) and he continues an interest in this problem.

Nancy Kanwisher is a Professor in the Department of Brain and Cognitive Sciences. She studies human visual perception and cognition, using functional magnetic resonance imaging to look at brain activity in people as they carry out visual tasks. Her work focuses on understanding the neural and cognitive mechanisms underlying object recognition and other aspects of visual cognition. She has identified several regions of the brain that play specialized roles in the perception of specific categories of visual stimuli such as faces and places.

Tomaso Poggio is the Uncas and Helen Whitaker Professor in the Department of Brain and Cognitive Sciences and in the Artificial Intelligence Laboratory. Dr. Poggio is also co-director of the Center for Biological and Computational Learning. He is a computational neuroscientist whose recent work focuses on the process by which the brain learns to recognize and categorize objects. His work is important not only towards understanding higher brain function, but also for its applications to computer learning.

We are pleased to report that James DiCarlo has accepted a faculty position and will join the McGovern Institute and the Department of Brain and Cognitive Sciences as an Assistant Professor early next year. Dr. DiCarlo is currently a postdoctoral fellow at Baylor College of Medicine and studies object recognition in the visual system.

Members of the Board of Directors of the McGovern Institute have been appointed and will hold their first meeting in the Fall. The Board is chaired by Patrick McGovern and other members include Lore McGovern, Elizabeth McGovern, Gerald Fischbach, Robert Langer, Edward Scolnick, Robert Silbey, Sheila Widnall, and Torsten Wiesel.

More information about the McGovern Institute can be found online at http://web.mit.edu/mcgovern/.

Phillip A. Sharp

CHANCELLOR

The Chancellor's office was reinstituted by the President on August 1, 1998. In recreating the office, the President transferred a number of responsibilities from the Office of the Provost to the Office of the Chancellor. These include broad oversight for graduate and undergraduate education, student life, strategic planning, campus development, and the management of the Institute's large-scale institutional partnerships.

REORGANIZATION OF THE OFFICE OF THE DEAN OF STUDENTS AND UNDERGRADUATE EDUCATION

In last year's report, I described the plan to reorganize the Office of the Dean of Students and Undergraduate Education. The reorganization was implemented this past year. Dr. Larry G. Benedict, formerly Dean of Student Affairs at Johns Hopkins University, was appointed Dean for Student Life following a national search. Professor of Physics Robert P. Redwine, formerly Director of the Laboratory for Nuclear Science, was appointed Dean for Undergraduate Education. Both deans have moved swiftly to implement the reorganization plan. As part of the reorganization, the offices of these two deans, along with the Senior Associate Dean Robert M. Randolph, were moved to the first floor of the Infinite Corridor to facilitate better interaction with the undergraduate population. In addition, the Office of Minority Education was moved to space immediately across the Infinite Corridor from the offices of the two deans. Additional space changes were made to consolidate staff in the Registrar's Office, as well as the Office of Student Financial Services, Academic Services, and the Teaching and Learning Laboratory. In addition, space was allocated for the Technology Enabled Active Learning Program directed by Professor of Physics John W. Belcher.

RESIDENCE SYSTEM REDESIGN

Planning for the implementation of President Vest's decision to house all freshmen on campus continues. Dean Benedict's office assumed responsibility for implementation of the Chancellor's final report on the redesign of the residence system. As part of this process, additional resources were allocated to the Office of the Dean for Student Life to add additional programmatic support for residential life. In addition, a number of Residence Based Advising programs were piloted this past year. These programs received largely favorable reviews, and will be expanded this next year.

UNDERGRADUATE AND GRADUATE HOUSING

This past year, construction began on the new undergraduate residence to be named Simmons Hall, in recognition of a $20 million gift in support of student life and campus activities received from Richard and Dorothy Simmons. Construction on this project began following the settlement of a lawsuit brought by an abutter to the site. Executive Vice President John Curry and Mr. Steven C. Marsh, Director of Real Estate, played important roles in helping to settle this litigation. Construction is expected to be complete by the start of the fall term 2002.

Construction also began on a new student residence located at the intersection of Sidney and Pacific Streets. This residence will house approximately 700 students. We anticipate that this residence will be devoted to graduate students. However, it has been designed to accommodate undergraduate students should the opening of Simmons Hall be delayed. It is expected to open in the fall of 2002 as well.

Construction also began this year on a new graduate residence located at 224 Albany Street. This graduate residence will contain approximately 120 units of loft-style housing. Professor Steven Lerman and his wife Lori will be the housemasters for this new graduate residence. It will open in August of 2001. Upon the opening of these two new graduate residences, the Institute will be able to offer on-campus housing to approximately 45 percent of its graduate student population.

ZESIGER SPORTS AND FITNESS CENTER

Construction began this year on the Zesiger Sports and Fitness Center. The Chancellor's office spearheaded fund raising for this new facility, which will house a 50-meter Olympic pool, 14,000 square feet of weight training and exercise facilities, a new sports medicine facility, new squash courts, multi-purpose courts, and new administrative offices for the Department of Athletics, Recreation, and Physical Education. Commitments for major gifts were received from Albert L. and Barrie R. Zesiger to name the building, Alex and Brit d'Arbeloff to name the men's and women's locker rooms, Thomas P. Gerrity to name the Health Fitness Center, and Michael Kasser to name the Sports Medicine Facility. This new facility will open in time for the fall 2002 term.

In concert with the planning of new athletic facilities, the Chancellor's office also supported the development of a new strategic plan for the Department of Athletics, Recreation, and Physical Education. This plan, which is nearing completion, will articulate priorities for intercollegiate athletics, intramural athletics, physical education, and recreational sports.

STUDENT MENTAL HEALTH

In response to concern over a number of recent suicides, the Chancellor's office initiated a comprehensive study of student mental health services at MIT. The Task Force on Student Mental Health is co-chaired by Dr. Kristine A. Girard and Mr. David A. Mellis, an undergraduate student. The Task Force is evaluating the entire range of services designed to support our students' mental health needs. It is also gathering data to benchmark our students' mental health services against those services provided by our peer institutions. The Task Force is expected to issue its final report in the fall of 2001.

CAMBRIDGE-MIT INSTITUTE

This past fall, seven MIT students departed for Cambridge University as the first undergraduates in the exchange between Cambridge and MIT. These students participated in a pilot program. In academic year 2001–2002, we expect approximately 25 MIT students will study at Cambridge, and a comparable number of Cambridge students will study at MIT. In addition, numerous faculty from MIT and Cambridge participated this past year in workshops sponsored by the Cambridge-MIT Institute (CMI). These workshops were designed to identify potential areas of joint research. CMI funded a number of joint research projects this year. In addition, CMI began work on adapting a number of professional masters programs, originally developed at MIT, for implementation at the University of Cambridge. Finally, MIT faculty and staff participated in a number of activities sponsored by the National Competitiveness Network (NCN). NCN is administered by CMI and organizes a number of British universities into a consortium focused on improving the competitiveness and productivity of British industry.

SPACE PLANNING

The Committee for the Review of Space Planning (CRSP), chaired by the Chancellor, spent $29 million to renovate space throughout the Institute this year. Major projects included the renovation of the fifth floor of Building 9 for the Department of Urban Studies and Planning, the planning for the consolidation of major parts of the Department of Physics, improvements to both classroom and office space for the Department of Materials Science and Engineering, renovation of the fluid mechanics laboratory in Mechanical Engineering to create the new Hatsopoulos Microfluids Laboratory, relocation of the News Office from Building 5 to Building 11, major renovations to The MIT Museum, improvements to the libraries in Building 14, and completion of phase 2 of the consolidation of astrophysics in the Center for Space Research. In addition, CRSP also funded major improvements to laboratory and classroom space throughout the Institute.

COUNCIL ON THE ENVIRONMENT

The Chancellor continued to co-chair the Council on the Environment with Professor David H. Marks. Together with Professor Marks, the Chancellor assisted in broadening the base of support for the Alliance for Global Sustainability, the collaboration between MIT, the University of Tokyo, and the Swiss Federal Institutes of Technology. This year, the Chancellor also facilitated the merger of the Center for Environmental Initiatives with the Energy Laboratory into the newly formed Center for Energy and the Environment. Professor David Marks will head this new center. This merger recognized the evolving common intellectual agenda of these two research programs. Over time, much of the work of the Energy Lab reflected growing concern for the environmental consequences of the development of new energy sources and technologies. As a result, increasingly the same faculty were collaborating on projects sponsored by both the Energy Lab and the Center for Environmental Initiatives. The merger brings these faculty together and also results in some reduction in administrative overhead. It was accomplished with the cooperation of all the participating faculty and departments. Following the creation of the Center for Energy and the Environment, the Chancellor and the Council worked together to consolidate the Center for Energy and Environmental Policy Research, the Joint Program on the Science and Policy of Climate Change, and the Center for Energy and the Environment on the fourth floor in Building E40. Through consolidation of these various research activities into adjacent space, we hope to encourage more collaborative research across the various schools in the area of the environment.

INDUSTRIAL PARTNERSHIPS

The Chancellor continued to provide oversight for two of the Institute's major industrial partnerships: The Ford-MIT Alliance and the Merrill Lynch-MIT Partnership. Both of these collaborations continue to show great promise. In order to learn more about how MIT can work more effectively with industry, the Chancellor's Office, together with the Office of Corporate Relations, is organizing a meeting for all of MIT Industrial Partners for the upcoming academic year. The purpose of this meeting will be to identify ways that the various partnerships can learn from each other, to evaluate new models for university-industry collaboration, to explore our mutual experience in transferring knowledge from the laboratory to the marketplace, and to identify best practices for addressing intellectual property issues.

CONCLUSION

This marks my last report as Chancellor of the Institute. It has been a privilege and an honor to serve the Institute in this role. Over the past three years, I have made many wonderful friends from throughout the Institute community, and have been blessed with truly wonderful colleagues. I am delighted that my long-time friend and departmental colleague, Professor Phillip L. Clay, will succeed me. I wish him great success.

More information about the Chancellor's Office can be found online at http://web.mit.edu/chancellor/.

Lawrence S. Bacow

ASSOCIATE PROVOST

The mission of the Office of the Associate Provost is to assist the Provost and other academic officers in carrying out academic and program support functions. The Office of the Associate Provost worked on the following activities in the past year.

The Office of the Associate Provost worked with the Ombudspersons, representatives from the Human Resources Department, and the offices of the Graduate and Undergraduate Deans to develop a protocol that will improve our grievance process and provide guidance and assistance to those who conduct investigations. We made considerable progress in drafting the guidelines, and the group will continue its work in 2001–2002, with the goal of developing a simple handbook, *the Investigation Guide*, and a concise process that will clarify how different areas of the Institute will conduct investigations.

The Child Care Committee, chaired by the Associate Provost, recommended the selection of Bright Horizons as the child care provider for MIT. This provider will operate the child care at Stata as well as the existing Technology Children's Center, Inc. (TCC) operations. The recommendation came during the summer and will be presented to the Academic Council for formal approval in the fall. The child care center in Stata represents a significant commitment to enhance child care and goes a long way to providing the 150 additional slots recommended by the Faculty Committee in 1999 chaired by Professor Leigh H. Royden. In addition to Stata, other sites are under consideration, but none yet has been chosen as a location to develop additional day care space.

Associate Provost reported to the faculty on the areas associated with implementation of the faculty vote on ROTC. No new progress was reported in our efforts to change the national policy or to improve the advocacy for changing that policy. There were no incidents where students were denied financial aid associated with any termination from ROTC. The Associate Provost pointed to a number of leadership initiatives that were started across the Institute, but as yet there was no formal program. These included initiatives where ROTC commanders played an active or leadership role.

A faculty committee chaired by the Associate Provost explored a set of issues related to intellectual property in the digital era. After consulting with faculty and various committees, the group generated a set of principles that should guide MIT's policies. The committee recommended that there be no change to policies and that the principles serve simply as guidelines for how faculty members in departments and laboratories consult and collaborate with each other, imposing upon them an obligation to seek permission from their department head when exceptions to these principles could occur. The committee will make recommendations for faculty review and action on this recommendation in the fall.

The Associate Provost investigated or supervised the investigation of five special cases this year. These cases involved both faculty and senior staff and included two cases carried over from previous years.

The Associate Provost along with Provost Robert A. Brown and Professor Nancy H Hopkins co-chaired the Faculty Diversity Council. The council was formed to identify ways of promoting increased recruitment, hiring, and retention of women and minority faculty. The committee organized its work in several areas including improving the search process by expanding the pipeline of potential candidates, improving retention, and improving faculty quality of life. The Associate Provost served as a member of the Quality of Life Committee, which pursued a number of proposals regarding faculty leave.

The Associate Provost collaborated with the faculty in generating a proposal for policy to provide a paid leave for junior faculty members between their second and sixth year. The aim is to provide a concentrated period of time when junior faculty members might pursue their work. The Institute will cover expenses associated with this program. Because some departments and programs already provide some relief to junior faculty in this regard, this new policy should be viewed as the minimum for all untenured faculty in the Institute. Some departments may want to provide a greater benefit than the one semester provided under this program.

Phillip L. Clay

INTERNATIONAL SCHOLARS OFFICE

The International Scholars Office (ISO) enables MIT faculty and staff to bring international researchers and professors to campus for a variety of purposes. The ISO advises on immigration matters, issues visa documents, and provides guidance, workshops, information booklets, and flyers on a wide range of issues relevant to the international scholar population. Weekly orientations are held for incoming scholars and family members. The ISO also engages in advocacy efforts to protect international educational exchange, prevent burdensome regulations, and clarify and improve related regulations and procedures. For the past six years, the ISO has benefited from the extremely helpful oversight of the Associate Provost, with invaluable assistance from Charlene Placido, Assistant Dean for Research. As Professor Phillip Clay moves from Associate Provost to the Chancellor position at MIT, ISO staff members are filled with gratitude for his excellent guidance.

MIT'S INTERNATIONAL SCHOLAR POPULATION

The ISO served a total of 1672 international scholars who were affiliated with MIT during the period July 1, 2000 to June 30, 2001, up from 1464 last year and 1369 the year before. The ISO also served these scholars' accompanying family members and other members of the MIT community. Over 60 percent of MIT's postdoctoral associates and fellows are foreign, as are over 50 percent of "visiting" appointees. International scholars are fundamental to the global scope of MIT's research and teaching efforts, and represent a dynamic and diverse group. During the past year, international scholars came to MIT from 84 countries, with the highest numbers coming from People's Republic of China (194), Germany (179), Japan (168), Republic of Korea (112), France (96), India (89), Canada (80), the United Kingdom (72), Italy (67), and Spain (50). MIT is among the United States institutions hosting the most foreign scholars, ranking sixth nationally. More information can be found in the ISO's annual report. In the past year, the ISO worked closely with administrators in 73 departments, laboratories, and centers, and prepared the appropriate visa documents or petitions for incoming and continuing scholars and their families. The areas hosting the largest number of scholars are the following, in descending order: Chemistry; Biology; Earth, Atmospheric, and Planetary Sciences; Sloan School of Management; Mechanical Engineering; Chemical Engineering; Civil and Environmental Engineering; Research Laboratory of Electronics; Department of Materials Science and Engineering; Center for Cancer Research; Brain and Cognitive Sciences; and the Laboratory for Computer Sciences. The majority of MIT's international scholars are sponsored on MIT's J-1 exchange visitor program. There were 1057 scholars under MIT's J-1 program sponsorship during the 2000–2001 period, and an additional 82 here through other J sponsors. There were also 224 scholars who were sponsored by MIT on the H-1B visa, reflecting a steady increase over 185 H-1B scholars in 1999–2000 and 148 in 1998–1999. The rest of the scholar population had other sponsors or nonimmigrant categories. (Note that some of the 1672 scholars held more than one visa status over the course of the reporting period.) The ISO also submitted 13 permanent residence petitions to the Immigration and Naturalization Service (INS) on behalf of MIT faculty members and upper-level researchers.

PRIMARY ACTIVITIES AND ACCOMPLISHMENTS

In order to advise the MIT community and this vibrant group of scholars, ISO staff members must be knowledgeable about complex, continually changing immigration laws and regulations and must coordinate MIT's needs, the scholar's unique qualifications and visa history, and regulatory realities. In addition to advising, preparing immigration documents, running a weekly orientation program, and providing extensive written and web-based information, the ISO again sponsored an annual tax workshop, using a new presenter who was well-received, and sponsored the annual fall International Open House for newcomers in partnership with the International Students Office. The ISO held workshops for new administrators and Human Resources, and further streamlined internal procedures.

Central to the ISO mission is ensuring that international researchers and faculty members are able to be affiliated with the Institute on a timely basis, in the desired capacity, and for the length of time desired by all parties. Each year, there are more variations in the kinds of affiliations individuals have with the Institute. This is a result of the increase in partnerships between MIT and industry, MIT's general increase in international partnerships and collaborations, and other factors. The ISO's goal is to be responsive and seek the best possible fit between somewhat archaic immigration regulations and current realities, while advocating for changes that would reduce unnecessary barriers and delays. The Institute is subject to increasing delays on the part of agencies involved in immigration-related processing, particularly the Immigration and Naturalization Service and Department of Labor. In addition, the J Exchange Visitor Program's transition to its new home in the Department of State continues to be incomplete, and many regulations and procedures need modernizing.

The ISO has many channels for remaining informed, discussing policies and procedures with colleagues within and outside MIT, and influencing federal legislation, regulations and policies relevant to MIT's international scholar population. Jack Crowley, Vice President for Federal Relations, remains key to furthering MIT's legislative efforts, and he and the Associate Provost provide critical guidance for a wide range of issues. The director has continued membership in the Consortium on Higher Education Immigration Issues, and both this group and the Ivy League

Institutions Plus Three group provide helpful forums for discussion of common issues. ISO staff participation in monthly local meetings is supplemented by active involvement at professional conferences and working groups of NAFSA: Association of International Educators. Dana Bresee Keeth, Director, was appointed to NAFSA's national Committee on Immigration Policy and Practice, and in that capacity serves as Chair of the Working Group on Exchange Visitor Issues. She contributed to a major proposal, now under review by the Exchange Visitor Program, to expand the time limit for exchange visitors and increase flexibility for intermittent visitors. She and Penny Rosser, Assistant Director, have also been proactive in attempting to influence H-1B related legislation and regulations. In a victory for the academic community, the American Competitiveness in the Twenty-First Century Act was signed into law in October 2000. This act established important exceptions for institutions of higher education and certain other entities and increased flexibility for H-1B employees moving from one employer to another. Most notably, MIT and other institutions are finally exempt from the numerical limitation on the number of new H-1B petitions that can be filed annually. Unfortunately, the Department of Labor regulations published in December 2000 have created a number of new obstacles and have aggravated the long-standing mismatch between H-1B requirements and academic realities. In addition to mastering a complex body of new information, ISO advisors revised all H-1B related processes and checklists, seeking to ensure institutional compliance, minimize the burden on administrators, and enhance efficiency.

The Immigration and Naturalization Service continues to develop a statutorily mandated national system by which international offices will eventually be required to electronically track and report information on international students and scholars to INS. The "SEVIS" program (previously called "CIPRIS" and then "SEVP") is controversial, and MIT and peer institutions are closely monitoring related developments. INS will soon issue a rule imposing a fee on incoming students and exchange visitors, and the new bureaucratic hurdles are likely to add to delays already experienced by those seeking visas for entry to the U.S.

The ISO is continuing its efforts to implement a new computer system (for its database, issuance of government forms, and reporting purposes), update the office web site, and review and update intake forms used by administrators and incoming scholars. Another focus of attention, in conjunction with the International Students Office, is better delineating criteria for sponsorship of individuals who are engaged in degree programs overseas and who will be affiliated with MIT. Space is another concern. The Institute is converting the adjoining MIT conference room in 4-109 into office space, and the ISO is now using the new conference room in 12-196 for weekly orientations, in addition to using classroom space at peak times. The Associate Provost received a request that the ISO be moved to another location, in order to facilitate unification of other administrative offices. This request is still under consideration.

PERSONNEL

The ISO benefits from a dedicated staff. Continuing without change from last year are Dana Bresee Keeth, Director; Penny Rosser, Assistant Director; Jennifer Stephens, part-time Advisor to International Scholars; Sharon Ralston, Advisor to International Scholars; and Michael Welch, Administrative Assistant. At the end of February, Ivana Hrga-Griggs left for another position, and in April the ISO welcomed Mary Schrot as the newest Advisor to International Scholars.

More information about the International Scholars Office may be found online at http://web.mit.edu/scholars/.

Dana Bresee Keeth

ASSOCIATE PROVOST FOR THE ARTS

The focus of the Office of the Associate Provost for the Arts during 2000–2001 has been on the development and sustenance of the expanding arts community with further development and planning for new resources for the arts, greater national engagement in arts initiatives, and a new focus on MIT's relationship to K–12 education.

RESOURCES AND PROGRAMS

Fall 2000 saw the relocation of Music and Theater Arts to its new offices in Buildings 4 and 10, providing more office space than its previous facilities in Building 14. It also gave the program greater visibility to the entire MIT community with an entrance so close to Room 10-250.

The new exterior to MIT Museum Building was nearly completed, except for some clean-up of the windows and brick on the existing building and the addition of a side banner. The windows, canopy, and new stairway entrance finally give the museum the presence on Massachusetts Avenue it has needed for a long time. The new admissions area has professionalized the look of the entire museum.

The move of the MIT Museum Store to the first floor of N51 was frozen this year, necessitating a severe cutback in store operations. The store manager and his assistant were let go and the inventory limited only to articles directly relating to MIT and the museum exhibits.

Through the work of consultant Patricia Fuller and Jane Farver, the best practice procedures for the MIT Percent for the Arts policy were embraced by the Academic Council. Jorge Pardo was selected to work with the architects for the new graduate students dormitory, and talks have begun with Frank Gehry about the art for the Stata Center.

In spring 2001, the Pilchuck School gave MIT a matching grant for one scholarship for a student to study glass art every summer. The MIT Council for the Arts created the Council-Pilchuck Scholarship to meet the grant annually. The first recipient was Helen Lee '01, a Council Scholar in the Arts.

In fall 2000, the MIT Jazz Quintet played a concert for the Chicago members of the Council for the Arts and the MIT Alumni Club in Chicago. They later played for the Council and the Alumni Club of Washington, DC at a meeting to honor Michael Kaiser, the new director of the Kennedy Center and an MIT alumnus.

Work continued on the programming of the Laboratory for the Performing Arts.

NATIONAL ENGAGEMENT AND K–12

This was the first year of operations for Teachers as Scholars with seven seminars being taught on the MIT campus to excellent evaluations.

The Associate Provost for the Arts participated in the Building a Field Conference to help create graduate programs in the development and administration of community arts programs.

The List Visual Arts Center initiated a team-taught course with the arts director of the Cambridge Rindge and Latin School, introducing high school students to opportunities for careers in the arts. One member of the class is already doing an internship with the Boston Museum of Fine Arts (MFA) this summer.

The MIT Museum expanded its offerings to K–12 groups and is in the process of filling a staff position in Educational Programs.

The Associate Provost for the Arts contributed an introductory chapter to the forthcoming volume of portraits of arts based K–12 schools from the Harvard School of Education, a project supported by the National Arts League Foundation.

The Associate Provost for the Arts continued to serve as the MIT representative on the Board of Trustees of the MFA and joined the Education Committee of the Board.

The Museum Loan Network (MLN) began a new partnership with the American Composers Forum by offering travel grants to composers. This was the outcome of a series of national think tanks organized by the MLN on the Museum as Catalyst for Collaboration.

THE ARTS COMMUNITY

In fall 2000 the School of Humanities and Social Sciences celebrated its 50th anniversary and was officially renamed the School of Humanities, Arts, and Social Sciences.

In spring 2001, the first Robert Muh Award to MIT to a graduate who has excelled in the humanities, arts, or social sciences was awarded to dancer/choreographer Gus Solomons.

Alan Brody

MIT LIST VISUAL ARTS CENTER

The MIT List Visual Arts Center's (LVAC) mission is to present the most challenging, forward-thinking, and lasting expressions of modern and contemporary art to the MIT community and general public in order to broaden the scope and depth of cultural experiences available on campus. The LVAC's mission also is to reflect and support the diversity of the MIT community through the presentation of diverse cultural expressions. This is accomplished through four avenues: changing exhibitions of contemporary art in all media by the most advanced visual artists working today that take place in the LVAC galleries (E15); the Permanent Collection of art (comprising large outdoor sculptures, artworks sited in offices and departments throughout campus, as well as art commissioned under MIT's Percent-for-Art policy which allocates funds from new building construction or renovation for art); the Student Loan Art Program, a collection of fine art prints, photos and other multiples, maintained solely for loan to MIT students during the course of the academic year; and interpretive programs to offer the MIT community and the public various perspectives about LVAC changing exhibitions and MIT's art collections.

CURRENT GOALS

LVAC's current goals are to:

- Continue to present the finest international contemporary art that has relevance to the MIT community;
- Continue to increase audience both from MIT campus and from Boston area; and
- Use new educator to increase cross-disciplinary and collaborative use of LVAC's exhibitions, programs and facilities.

ACCOMPLISHMENTS

This year LVAC increased attendance to the highest numbers since 1994, when actual attendance counts replaced estimated figures.

LVAC initiated ArtWorks, a program in conjunction with Cambridge Rindge-Latin High School. This after-school program provided tours and seminars for students interested in careers in the arts. Students met with the director, curators, registrar and exhibition designer at the List Center, toured the MIT Media Lab, and visited facilities and met with staff of other Boston institutions including the Museum of Fine Arts, the Gardner Museum, Fox News, Harvard Conservation Labs, Perry, Dean Rogers architects, Charles Webb Furniture Design, web-design firm Partners and Simons, and the Blue Man Group. This program was considered to be so successful that Rindge-Latin has asked that it be repeated, not as an after-school program, but during the school-day. They have committed a teacher and the computer labs to this program for the coming year.

LVAC instituted and found funding for a residency by artist Paul Pfeiffer. This will be a collaboration with the Artist-in-Residence Program of the Office for the Arts.

LVAC provided gallery tours of exhibitions to 63 groups.

Luca Buvoli—Flying: Practical Training for Beginners, originally organized by Jane Farver for the List Center, traveled to Austin Museum of Fine Arts in December 2000, where it was seen by more than 7,000 viewers.

LVAC secured outside funds to conserve Jean Ipousteguy's *Cenotaph* (located near the Bush Building) and partial funds to conserve Jacques Lipchitz's *Bathers.*

With Facilities and Planning Departments and the Sloan School, LVAC worked on the reconstruction of the plaza of the Sloan School and refurbishing of Bernar Venet's *Two Indeterminate Lines.*

LVAC conserved Beverly Pepper's *Trinity* which will be re-sited in the coming year.

LVAC worked with client groups and architects SLAM to commission artist Jorge Pardo to create a new work for the NW30 residence.

With Aeronautics and Astronautics client group, LVAC purchased two works by Candida Hofer.

A conservation survey of permanent collection sculpture was conducted on campus through an Institute of Museum and Library Services (IMLS) Conservation Assessment Program grant secured by LVAC.

During the annual MIT Council for the Arts meeting, LVAC hosted gallery exhibition tour for council members.

During the 2000–2001 season, LVAC made loans of approximately 200 artworks to various departments and individuals across the MIT campus.

LVAC participated in Freshman Arts Program Orientation and Campus Preview weekend programs, providing tours and receptions.

Under the sponsorship of the Council for the Arts, a collaborative program was initiated with the MIT Visual Arts Program and the Asian Studies Program for artists Isaac Julien and Paul Pfeiffer and Whitney Museum of American Art curator Chrissie Iles to meet with MIT students.

LVAC facilitated the List Essay Prize for writing on contemporary art, which was shared by Kathryn R. Nichols and Shelli Farhadian.

The Wasserman Forum on Contemporary Art, moderated by art historian Judith Rodenbeck and featuring artists Alan Kaprow, Paul McCarthy and Vanessa Beecroft, was reinstituted this year. It was attended by a full house in Room 10-250; and the donor considered this to be the most successful forum to date.

LVAC received more than 40 positive critical reviews for exhibitions, including positive reviews in The Boston Globe, The Boston Herald, The Boston Phoenix, The Harvard Crimson, Art on Paper, Art New England, New Art Examiner, Arts Media, ArtNews, ArtForum, Parachute, Museums Boston, Tema Celeste, Time Out NY, Austin American-Statesman, Austin Chronicle and MIT's Tech Talk.

LVAC purchased or received donations of 16 new works to add to the Student Loan Art Program, the majority of which were exhibited in the Stratton Student Center during the 2000–2001 academic year. They will be cycled into the lending collection in the fall of 2001.

EXHIBITIONS

Student Loan Art Exhibition (LVAC galleries, September 5 through September 17, 2000) is an annual exhibition of 350 works comprising Student Loan Art Collection. MIT students may view displayed works and then enter a lottery to be awarded the work of their choice on loan for the academic year to hang in their dormitory, apartment or office. This year 1,233 students attended the exhibition, an increase of 33% over the previous year.

Global Conceptualism: Points of Origin, 1950s-1980s (Hayden, Reference, and Bakalar Galleries, October 14, 2000–January 6, 2001 was organized by an international team of curators under List Center Director Jane Farver for the Queens Museum of Art). It looked at the history of conceptual art as it developed around the world and featured over 200 works by more than 130 artists from Africa, Asian, Australia and New Zealand, Eastern and Western Europe, Latin America, North America and the Soviet Union. This exhibition was listed as one of the five most important exhibitions of the past five years by Time Out New York (October 2001).

Inside Space (Hayden and Reference Galleries, January 27–April 8, 2001, curator: Bill Arning). An exhibition of international artists or artist/teams critically engaging the language of architecture, including Monica Bonvicini, Elmgreen and Dragset, Teresita Fernández, Juan Maidigan and Dolores Zinny, Henrik Olesen, and Oona Stern. The catalogue included essays by Arning and Joel Sanders and was distributed by D.A.P., New York.

Circa 1999: Photographs by Marco Breuer (Bakalar Gallery, January 27–April 8, 2001, curator: Bill Arning) was an exhibition of photographs made with non-photographic means.

Isaac Julien: The Long Road to Mazatlán (in collaboration with Javier de Frutos) and *Vagabondia* (Hayden Gallery, April 27- July 1, 2001, curators: Jane Farver and Bill Arning). Digital, multi-screen video projections by award-winning Black British filmmaker Julien. During the run of the List Center exhibition, Julien was nominated for the prestigious Turner Prize at the Tate Gallery in London.

Paul Pfeiffer: The Long Count (Rumble in the Jungle) (Reference Gallery April 27–July 1, 2001, curators: Jane Farver and Bill Arning). Digital video work investigating racial identity through the use of popular iconography, in this case the athlete Muhammad Ali.

Johan Grimonprez: Inflight Magazine (Reference Gallery April 27–July 1, 2001 curators: Jane Farver and Bill Arning). A video lounge installation featuring a take-off on airline magazines found on commercial flights.

Race in Digital Space (Bakalar Gallery, April 27–July 1, 2001, guest curator Erika D. Muhammad). The exhibition was presented in conjunction with the conference of the same name organized by MIT's Comparative Media Studies Program and the University of Southern California. It featured works by over 30 artists using film, video, new media and web techniques to explore how electronic culture influences the production of identity, race and nationhood.

INTERPRETIVE PROGRAM HIGHLIGHTS

LVAC curatorial staff led 65 gallery tours during the course of the exhibition year for the Visual Arts Program at MIT and for groups including the Museum School, Mass. College of Art, Rhode Island School of Design (RISD), the Art Institute of Boston, University of Massachusetts—Boston, Harvard University, Emerson University, Suffolk University, Dreyfuss University, Boston University, Gordon College, New England School of Art and Design, St. Scholastic Academy (Colorado), University of Massachusetts—Amherst, Polter Road School, Boston Aquarium staffers, the Stockholm School of Economics, and MIT's Council for the Arts, Artists Behind the Desk, and the Asian Studies Program.

Global Conceptualism: Points of Origin, 1950s-1980s curator Reiko Tomii and MIT Professor John Dower presented a public program on the social and cultural conditions of post-WWII Japan that led to the early development of conceptual art practice in the country.

Global Conceptualism: Points of Origin, 1950s-1980s curator Okwui Enwezor (the first African curator ever appointed as commissioner of the prestigious international exhibition *Documenta*, held every five years in Kassel, Germany) outlined his plans for *Documenta 11* in a public program presented in Bartos Theater.

Global Conceptualism: Points of Origin, 1950s-1980s curators Rachel Weiss and Luis Camnitzer presented a walk-through tour of the exhibition.

Art Historian Ondine Chavoya spoke about the work of *Global Conceptualism* artist Harry Gamboa. This event was co-sponsored by MIT History, Theory and Criticism program of the Department of Architecture.

Award-winning Japanese designer Eiko Ishioka presented a lecture in Bartos Theater. This event, co-sponsored by the Japan Society of Boston, was available free to MIT students (cost to Japan Society Members $30).

Inside Space artists talked about their work in the gallery for MIT Visual Arts Program and LVAC Artworks students.

Artists Isaac Julien and Paul Pfeiffer spoke about their work in a public conversation with Whitney Museum of American Art Curator Chrissie Iles.

ABCD (Artists Boston Critical Dialogue) presented a program on Boston's alternative spaces in Bartos Theater.

Films presented in Bartos included: Michael Snow's *Wavelength*, Hollis Frampton's *Zorns Lemma*, Isaac Julien's, *Looking for Langston* and *Young Soul Rebels*, and Johan Grimonprez's *dial H·i·s·t·o·r·y*.

A potluck dinner for artists connected with Boston's alternative arts community was held.

Regularly scheduled gallery talks by the curators were instituted. These were well attended and will take place on a biweekly basis in the coming year.

COLLECTIONS

There were five gifts of art to the collection including works by Elizabeth Murray, Sol LeWitt, Peter Garfield, and Kim Sooja. Donors included Vera G. List and Kitty and Herb Glantz.

The Student Loan Art Program attracted 1,233 MIT students to the LVAC gallery over the period of the exhibition of artworks. A total of 525 students submitted entries to the lottery to borrow artwork and approximately 300 works were disbursed.

ADMINISTRATIVE CHANGES

Director Jane Farver and Percent-for-Art coordinator Patricia Fuller worked with the Director of Capital Improvements and project managers to write a *Best Practices Policy for the Implementation of the Art on Campus Policy*. The *Best Practices Policy* was then presented to and approved by Academic Council.

Director Jane Farver attended Getty Leadership Museum Management Institute Program In Berkeley, CA, an intensive three-week course designed for museum directors.

LVAC formed a Long Range Planning Committee composed of Advisory Council and staff members.

A weekly long-range planning meeting for staff was instituted.

LVAC restructured staff to include one curatorial position dedicated to collection and percent-for-art projects and a position dedicated to education and outreach.

Fourteen interns from Harvard, RISD, Tufts, Mass. College of Art, School of Museum of Fine Arts, McGill University, Colby College and Skidmore College trained at LVAC.

The gallery floors were refinished.

FINANCES/FUNDING

LVAC received the following donations: $40,000 grant from the Andy Warhol Foundation, $10,000 from the Boston Foundation, $2,000 from Sally and Milton Avery Foundation, $2000 from the Cambridge Arts Council, $10,000 from the LEF Foundation, $1,250 from Goethe Institute, $15,000 from the Massachusetts Cultural Council, $4,500 from the Saul Rosen Foundation, $500 from Harvard University, $25,000 from the MIT Council for the Arts, $500 from MIT Campus Committee on Race Relations, and in-kind donations from the Royal Sonesta Hotel and Home Depot.

FUTURE GOALS

Future goals are to:

- Use LVAC web site to provide information about Student Art Loan Program and permanent collection. Also to provide additional opportunities for artists to do web-based projects, beginning with Matthew Ritchie who is creating a new work for the Central Athletic Facility under the MIT Percent-for-Art Program. This requires outside expertise, a digital camera and new software.
- Develop comprehensive educational materials about all of the MIT Percent-for-Art projects. We would like to create documentary video tapes about the percent for art and artist residency project. This requires additional funding and expertise.

- Develop comprehensive program of exhibitions and public programs consistent with MIT's mission that can attract large-scale funding.
- Present art in other sites on campus, beginning in the coming year by programming the Media Wall in Building 16, presenting a film based on Mozart's *Magic Flute* in the MIT Chapel and creating a small exhibition of works by contemporary Japanese artist Yukinori Yanagi for the MIT Japan Program offices.

PERSONNEL INFORMATION

Tim Lloyd joined the LVAC staff as gallery manager/exhibition designer in September 2000.

Director Jane Farver received a grant from the Asian Cultural Council to travel for one month to study new media art in Japan. She completed two weeks research in May 2001 and will complete the project in the coming year. She participated in a curatorial conference at the Baltimore Museum of Art, and grant-making panels for Etant-donnes for the Government of France in Paris and Chicago. She was a panelist for the National Endowment for the Art's Japan Program, the Bogliasco Foundation (Genoa), Creative Capital Foundation (New York), the Cambridge Arts Council, and was a member of the Asia Society's (New York) Core Advisory Group. She delivered a paper on conceptual art at an international curatorial conference in Seoul, South Korea (as part of the Kwangju Biennial curator's committee), a lecture at University of Massachusetts—Amherst, contributed an essay to *Words of Wisdom: A Curator's Vade Mecum,* published by Independent Curators, Inc., NY, and participated in a panel for the book launch at DIA in New York.

Curator Bill Arning presented lectures at RISD, Mass. College of Art, the Museum School in Boston, The School of the Art Institute of Chicago, the Institute of Contemporary Art in Boston, and Wake Forest University. He was a panelist or juror for the Silvermine Arts Foundation, the Cambridge Center for Adult Learning and Tufts University. He contributed essays to catalogues produced by Bowdoin College, Molloy College, and Southhampton University.

ADVISORY BOARD CHANGES

Jean Stanton joined the LVAC Advisory Board Committee.

More information about the MIT List Visual Arts Center can be found online at http://mit.edu/lvac/.

Jane Farver

MIT MUSEUM

The MIT Museum exists to document, interpret, and communicate to a diverse audience, the activities and achievements of MIT and the worldwide impact of its innovation, particularly in the fields of science and technology; and to enhance the spirit of community inside the Institute through the promotion of dialog both at MIT and between the Institute and the wider world.

HIGHLIGHTS

This year saw a complete transformation of the Museum as we began implementation of our five-year strategic plan.

We opened two major permanent exhibitions in the main gallery space. *Beyond Robots: Exploring Artificial Intelligence at MIT,* a collaboration between the Museum and the Artificial Intelligence (AI) Lab, opened in October to rave reviews. A record 1,700 people visited the Museum on its opening weekend. It features a number of cutting-edge interactive exhibits and enables our visitors to take a peek at what is going on behind-the-scenes in one of the most exciting areas of MIT research. In June, the Museum opened its long-awaited exhibition that tells the story of MIT from its founding to the present day. *Mind and Hand: The Making of MIT Scientists and Engineers* tells this story from the student perspective, and includes over 200 artifacts ranging from 19th-century historic instruments, the cavity magnetron that formed the basis of the technology developed at the RadLab, to a Toscanini's coffee cup! It also marked a major fund-raising achievement for the Museum's Advisory Board.

After many design changes, including the loss of the first floor store, the Museum's exterior renovations were completed in early summer. The Museum now has a new entrance stairway, first floor display windows (that include a piece by MIT Artist-in-Residence Arthur Ganson), a renovated second floor reception area, and a new visitor

services desk. Designed by Associate Professor Wellington (Duke) Reiter of Urban Instruments Inc. the renovations give the Museum an exciting and more welcoming street presence that reflects the quality of the exhibits within. Behind-the-scenes there has been a considerable amount of work on reorganizing and refurbishing the collection storage areas. In addition, the Museum's deaccessioning program has continued at a steady pace.

Together with the Publishing Services Bureau, the Museum redesigned its web site to conform to our new graphic identity and also to make it easier to navigate. The Museum was also the pilot site for e-commerce at MIT with the development of an online ordering ability for the Museum store.

The Museum served 43,665 visitors this year, an increase of 15 percent over last year's total admission figures. The number of visitors has increased by 75 percent over the last three years and we expect further increases with the refurbishment of the exterior of the building.

COLLECTIONS

The Collections Committee met four times and considered 12 acquisitions of which ten were accepted into the permanent collection. The Museum continued with its major deaccessioning program, which took up a great deal of Committee time. Publications continued to be passed on to other MIT departments and again, were offered to alumni/ae over Tech Weekend in early June. A number of musical scores and recordings were transferred to the Lewis Music Library and several items of furniture were sent for auction. The Morton Bradley mathematical sculptures were returned to Mr. Bradley together with the return of those pieces that had been on display. There were 31 loans in and out of the collections—the majority associated with our two new exhibitions. Several watercolors from the Hart Nautical Collections were loaned for exhibit to the New Bedford Whaling Museum.

ARCHITECTURE AND DESIGN COLLECTIONS

The Museum has been without a Curator of Architecture and Design this year, which has, necessarily, curtailed activities. However with the assistance of a temporary staff member, Roysin Billet, the collection has remained open. There were 33 telephone inquiries, 11 email and written requests, and three researchers using the Collections on site. Work on the TAC collections continued with all 1,200 of the early drawings (1946–51) being cataloged and rehoused. This project was supported by the Graham Foundation. Catalog sheets of early student theses and the Chamberlain collection were transferred to the computerized database.

HART NAUTICAL COLLECTIONS

The focus for the Hart Nautical Collections has been on long-range planning for the expected Burroughs endowment. Inquiry levels remained high with about 1,200 inquiries received via phone, fax, email and regular mail. These inquiries generated $13K in total revenue ($8K in plan and photo sales, $3K in fees and royalties and $2K in wholesale sales of guides to collections).

The second year of the IAP boat building program was very successful. Seven graduate students from courses II, IV, VI and XIII worked intensely over two weeks in the Department of Architecture's woodshop to complete the second shellback rowing/sailing dinghy. The boat has joined the first boat at the MIT Nautical Association's fleet. This matched pair becomes a new racing option for Nautical Association members. The project was funded by John Lednicky's '44, annual gift of $5K to the MIT Museum.

The curator assisted the Department of Ocean Engineering in planning the program for the 100-year anniversary of Course XIII-A this past April.

HOLOGRAPHY COLLECTIONS

This year has been busy for the Holography collections. Partly funded by the Shearwater Foundation, the temporary documentation assistant Steve Maloney finished cataloging the entire collection of holograms, a process that added a great deal of information to the database from many different sources. The collection was also rehoused and a new inventory list prepared. A second grant from the Shearwater Foundation will enable us to put the database online later this year. The Museum also hosted a "thinktank" weekend with three senior members of the holography community to discuss the future development of the collection. A number of collecting goals were developed, together with some criteria for deaccessioning material, that will guide the Collections Committee in its decision-making.

There were 20 inquiries to the collection and one major acquisition—the collection of Anait Stephens, donated by her husband Ralph Stephens. Anait Stephens was an early and prominent artist in the field and her work covers a broad spectrum of the holographic technology.

PHOTOGRAPH AND FILM COLLECTIONS

The historic photograph collection continued to receive heavy use with over 300 requests and 120 visitors. Ninety requests for photographs were fulfilled. Images were provided to a variety of MIT departments and offices including the Alumni Office (125th anniversary and reunions), Endicott House and the Department of Facilities. The collection was used extensively by academics and students both from within MIT and from other institutions particularly in the development of educational web-based material. Areas of focus for academic publications were diverse—from probability and finance to the history of flight. Images from the collections appeared in the PBS series *Great Entrepreneurs* and *Hal's Legacy*. The collection also assisted other museums such as Museum of Science and Industry in Chicago, and the Guggenheim Museum in New York.

The database of the Museum's film and video collections was expanded in preparation for the assessment of the film collection for an NEH preservation grant. Together with a specialist moving image consultant, a conservation plan for this irreplaceable collection is being prepared.

SCIENCE AND TECHNOLOGY COLLECTIONS

The main focus of attention this year was the research, development, design and fabrication of *Mind and Hand: The Making of MIT Scientists and Engineers*. The new exhibition showcases more than 200 artifacts from the Science and Technology Collections (this includes a small number on loan from Harvard and Dartmouth).

Over 100 inquiries about artifacts and related archival materials were dealt with. The curator helped with television documentary programs for Japanese television and WGBH—Boston and also assisted photographers and authors from *Air and Space Smithsonian*, W.W. Norton, and Boeing.

There were several accessions this year including a carbon dioxide laser with power supply and two lead-salt diode lasers from General Motors, 50 19th-century thermometers and eight EG&G artifacts (including three electronic flash tubes, three hydrogen thyratrons, a KR-3 Traveling Wave Cathode-Wave Ray Tube, and a DN-11 Neutral DC Relay for testing atomic devices) from Perkin-Elmer Inc. Several artifacts were loaned to the National Building Museum.

The curator lectured to an MIT Program in Science, Technology and Society (STS) class of approximately 30 students and supervised one UROP project and an STS graduate student independent study project (fall 2000) as part of the development of the *Mind and Hand* exhibition.

EDUCATION AND OUTREACH

The Museum's monthly family program series, *Family Adventures in Science and Technology (F.A.S.T.)*, and the *Friday After Thanksgiving (F.A.T.) Science Chain Reaction* with Arthur Ganson, continued to attract substantial media attention and record numbers of enthusiastic visitors to the Museum. This year, hands-on *F.A.S.T.* programs were co-developed and generously staffed with students, faculty and researchers from the Departments of Architecture, Chemistry, Earth, Atmospheric and Planetary Sciences, the Artificial Intelligence Laboratory and the Center for Theoretical Physics. Together *F.A.S.T.* and *F.A.T.* programs provided high-quality, MIT-centered science and technology experiences to over 4,000 visitors.

The Museum piloted its first ever drop-in vacation programs in the February and Easter vacations with programs on architecture (Build-It) and the Media Lab's Cricket Technology (Invent-It). These were extremely successful, increasing visitor numbers over those periods by 20 percent. The closing of the long-running *Hall of Hacks* exhibition was marked by Ultimate Hack Week, where visitors cast their votes for the best hack ever—the Harvard-Yale football game won. Other special events included a "Cambridge Kids Free" weekend in January that attracted many local families and a series of special evenings of "Who Wants to Win Just About Anything but a Million Dollars," a spoof on the popular game show, for MIT students.

The Museum's popular school and group programs served over 4,000 students throughout the state and greater New England. Many MIT students continued to help lead these programs, contributing greatly to their success. The Museum's school and group programs have fostered an increase in the diversity of the Museum's audience by

successfully extending its reach into communities traditionally underserved by museums. The Museum continued its relationship with the Haggerty Elementary School in Cambridge. As well as several visits to the Museum, the children were involved with the development of *Thinkapalooza* and took part in the Museum's special event, "Night of the Robots." A small group of local high school science teachers worked with the education co-ordinator to produce an educational handbook associated with the *Approaching Chaos* exhibition, which will accompany the show when it travels.

EXHIBITIONS

FY2001 was a banner year for exhibitions at the Museum. A new interactive zone, *Thinkapalooza*, opened in the summer of 2000. The area featured exhibits from several MIT departments including Ron MacNeil's virtual "Metafield Maze" that continues to delight and frustrate visitors and a special mural made of Toobers and Zots prepared by children from the Haggerty Elementary School.

On October 25, 2000 *Robots and Beyond: Exploring Artificial Intelligence at MIT* opened with record-breaking attendance. This project was a close collaboration with researchers and students from the AI Laboratory at MIT who were involved in all the planning stages and provided many of the stunning robots on display. The show features an inside look at research and experimentation being done on campus including famous MIT robots like Cog and Kismet, the science of artificial limbs, haptic technology and voice recognition systems.

Mind and Hand: The Making of MIT Scientists and Engineers opened on June 7. This, the Museum's core exhibit, explores, from the student perspective, the cultural curiosity that is an MIT education. The hallmarks of that education—disciplined creativity and learning by doing—have driven the educational philosophy at the Institute from 1861 to the present day. From rockets and slide rules, radar and nerd kits, the exhibition features many artifacts from the collections, rare photographs, video and sound recordings and hands-on demonstrations. The planning process involved all parts of the MIT community including alumni/ae, students, faculty, and staff, with many individuals also loaning special items for the show.

COMPTON GALLERY

The Museum installed three exhibitions in the Compton Gallery. Collaborating with the School of Humanities, Arts, and Social Sciences, the Museum produced an exhibition *A Fifty-Year Reflection: Humanities, Arts, and Social Sciences* in the fall of 2000. Curated by faculty member Ken Manning the exhibition panels are now hanging in Building 14 as a permanent exhibition on the history of the School. *Approaching Chaos*, developed by the Museum and funded by NSF, opened in February 2001 and received a great deal of press interest. The exhibition showcases the stunning images of classical and wave chaos by theoretical physicist Eric Heller and is now showing at the Edgerton Explorit Center in Nebraska. The Museum also hosted *Beyond Appearances: Imagery in Science at the Millennium* in association with the Image and Meaning conference at MIT in June.

TRAVELING EXHIBITIONS

Two traveling exhibitions currently offered by the Museum are touring museums throughout the United States: *Seeing the Unseen: Photographs by Harold Edgerton* and *Approaching Chaos.*

DEVELOPMENT AND COMMERCIAL SERVICES

Our development efforts during the year were very successful, with $393,659 raised to help fund operating costs, new exhibitions and education programs, and the Architecture and Design, Hart Nautical, and Holography Collections. We appreciated the Organizational Support Grant from the Massachusetts Cultural Council that enabled us to hire museum facilitators to assist our visitors and enhance their experience of the museum.

The Development Committee in partnership with the chair of the Advisory Board worked diligently to secure gifts totaling $234,650 for the exhibition *Mind and Hand: The Making of MIT Scientists and Engineers.* Nineteen donors including the Council for the Arts, a corporation, six foundations (the Grayce B. Kerr Fund, Inc. and the David P. Wheatland Charitable Trust among them), and 11 alumni generously contributed to this project. Another 12 donors, including Beacon Skanska Corp., made in-kind gifts of materials and services that were invaluable to the quality of the exhibition.

We were honored to receive several gifts in memory of our late long-time friend and Advisory Board member, Trude Beck, that were used to support public programs for K–12 students, families and adults, a special interest of hers.

The Council for the Arts, T. Backer Fund, and John Lednicky '44 OE provided critical funding to enable us to develop new hands-on education programs for a wide audience. Bristol-Myers Squibb joined us in sponsoring the "Who Wants to Win" series of programs for MIT students.

Our collections staff was able to accomplish significant work in rehousing, preserving and cataloging our Architecture and Design and Holography Collections thanks to grants from the Alice Willard Dorr, Marion L. Decrow, Graham, and Shearwater Foundations, the Greentree Fund, and Ralph Stephens.

The Museum made the difficult decision to greatly reduce its retail operations at the end of the year. We were unable to move the store to the first floor as originally planned, and it was not financially viable to continue to run the store in its location on the second floor. Instead the Museum will sell a limited number of items through the new Admissions Desk, which has been designed to display merchandise. The Museum also closed its catalog operation and has entered into an agreement with the MIT COOP who will provide online, telephone and mail ordering for a number of items under the rubric "MIT Museum Collection." The Museum continues to rent its space for special events and functions.

PERSONNEL

The Museum's Director of Exhibitions and Public Programs Janis Sacco left at the end of February to take up the position of Director of Exhibitions at the Harvard Museums of Natural History. Her replacement, Beryl Rosenthal, started at the Museum in May. Ken Murphy, the assistant manager of the Museum shop left the Museum in March. Jeff Fitzgerald and Cate MacKinnon were promoted to senior visitor services attendants in May as part of the reorganization of the Museum's commercial and visitor services, to reflect their increased job responsibilities.

FUTURE PLANS

The Museum's five year strategic plan defines ten strategic objectives for the Museum: to increase participation of the MIT community in the Museum's activities; to improve our services to visitors; to develop new exhibitions and educational programs that effectively communicate the breadth and diversity of MIT activity; to focus on collection development and refinement; to improve documentation and preservation of collections; to collaborate with others to interpret and communicate the Institute's history; to develop the Museum's online presence; to expand and extend the reach of Museum exhibitions and educational programs to new and larger audiences; to diversify the base of the support for the Museum; and to develop the Museum's operating infrastructure to meet the needs generated by growth. The accompanying three-year implementation plan details the following key objectives for FY2002:

- Complete second phase of renovation and reorganization of basement storage areas.
- Plan and begin fundraising for a new education and public programming space in the area vacated by the Museum store.
- Continue development of our web site to become a 'virtual' museum.
- Launch a Museum 'friends' program.

More information about the MIT Museum can be found online at http://web.mit.edu/museum/.

Jane Pickering

MUSEUM LOAN NETWORK PROGRAM

The Museum Loan Network (MLN) facilitates the long-term loan of art and objects of cultural heritage among U.S. institutions as a way to enhance the installations of museums, thus enabling them to better serve their communities. The MLN grant programs help museums respond to the increasing public demand for installations that are relevant to a range of age groups and cultural heritages, and to provide better artistic, cultural, and historical contexts for works on display. The MLN programs have led to the sharing of objects among different types of museums, fostering collaborations between institutions of varying size and discipline throughout the US. Funded and initiated by the John S. and James L. Knight Foundation and The Pew Charitable Trusts, the MLN is administered by MIT's Office of the Arts.

The program continues to expand its emphasis on network building, both through human and technological resources. The MLN's initiative, begun in the fall of 1999, to include a range of objects of cultural heritage

previously outside its domain, continues to evolve. This year, the MLN piloted a collaborative program with the American Composers Forum (ACF). This pilot program provides museums with an opportunity to work with composers and create new music for their communities. By bringing new music and the creative energy of composers directly into museums and their communities, the MLN hopes to create new models for interdisciplinary collaboration and enhance the quality of the MLN projects involved in these partnerships. In April 2000, the MLN began a series of convenings on the topic of "The Museum as Catalyst for Interdisciplinary Collaboration." After the first convening in Lexington, KY in April 2000, the MLN hosted two convenings at MIT in October 2000 and June 2001. Leaders from the fields of art history, history, music, dance, theater, philanthropy, art, public television, science, education, libraries, and museums met to grapple with the complex issue of collaboration. The MLN is currently working with the consulting firm Wolf Keens & Co. on a comprehensive on the three convenings which will be distributed in the fall of 2001.

The MLN on-line directory, a practical means of identifying objects of cultural heritage available for long-term loan to eligible museums throughout the U.S., now contains 6,000 objects from 43 institutions. The MLN continues to develop virtual exhibitions on its homepage. Featuring projects made possible by MLN implementation grants and designed in conjunction with MIT's Educational Media Creation Center (EMCC), these virtual tours not only provide visual models for museums to understand how to creatively utilize MLN, but also stimulate public interest in the arts and provide greater access to museums' hidden permanent collections. There are now nine virtual exhibitions on the MLN homepage featuring installations from the Eiteljorg Museum of American Indians and Western Art, Fitchburg Art Museum, Harn Museum of Art, Joslyn Art Museum, Los Angeles County Museum of Art, Mint Museum of Art, Mobile Museum of Art, Williams College Museum of Art, and University of Kentucky Art Museum.

The MLN continues to work with communications consultant Resnicow/Schroeder who was hired in the fall of 1998 to lead an aggressive press initiative. This year, the MLN and Resnicow/Schroeder have developed a slightly revised communications strategy that emphasizes outcome rather than process. The MLN has been very pleased with the long term results of the initiative which included a feature article in The New York Times on May 2, 2001. In October 2000, the fourth MLN newsletter, Museum Loan Network News 1999–2000 was printed at a run of 5,000 copies and distributed at museum conferences and by mail. This issue prominently featured the programming aspect of MLN-funded projects to highlight the new outcome-based emphasis. In February 2001, the MLN sent out a New Year's card listing all the MLN grantees and designed to indicate how wide its reach has been within its first five years. The MLN has continued to periodically send out postcards of selected objects from the MLN Directory. The intent of the postcards is to promote the Directory and encourage museums to check it periodically for new additions. The last postcard, sent in April 2001, featured a Barkeepers Vest from the Museum of American Political Life. The MLN Director and/or Program Associates attended and/or lectured about the program and related museum issues at the following annual meetings: the American Association of Museums Meeting, St. Louis; the Grantmakers in the Arts annual conference, Minneapolis; the combined American Association for State and Local History and Louisiana State Museums conference as well as the New England Museums Association annual meeting. The MLN was also represented by a booth at most of the above-mentioned conferences.

The MLN awards three types of grants to eligible nonprofit institutions in the U.S.: travel grants, survey grants, and implementation grants. At the February 2001 and June 2001 Advisory Committee meeting held at MIT, 43 grants totaling $848,962 were recommended for approval by MIT for funding to museums throughout the country. These awards will facilitate the sharing of diverse types of objects such as photographs, decorative arts, furniture, machinery, musical instruments, sculptures, and paintings among museums of differing disciplines ranging from historical societies to natural history museums to culturally-specific institutions to art museums. Survey grants include a variety of objects that will be added to the MLN directory, including American folk art from the Huntington Museum, WV; African American objects from the Anacostia Museum and Center for African American Studies, DC; contemporary Indian art from the Peabody Essex Museum, MA; Jewish art objects and artifacts from the Yeshiva Museum, NY; and musical instruments from the Museum of Fine Arts, Boston, MA. Travel grants were awarded to the Pueblo of Jemez Museum of History and Culture, NM; the San Angelo Museum of Fine Arts, TX; and The Newark Museum, NJ, among others. Implementation grants were awarded to such diverse institutions as the Museum of the New South, NC; the Spencer Museum of Art, University of Kansas; the Seattle Art Museum, WA; and the Western Heritage Center, MT.

The MLN will continue to explore new collaborative relationships (modeled on the ACF pilot partnership begun this year) to ensure its relevance to museums and their communities. The MLN Sustainability Plan, compiled last summer by Lucinda Barnes of Museum Management Consultants, sought to assess the long-term sustainability of the program and to provide perspectives into continued fundraising options. The sustainability plan would allow the MLN to change and grow in order to meet the demands of changes in society, technological advancements, and museum culture. In the coming year, the MLN will be seeking new funding sources to ensure its long-term viability.

PERSONNEL CHANGES

Ginger Hargett, administrative assistant, was hired in September 2000.

More information about the MLN can be found online at http://loanet.mit.edu.

Lori Gross

OFFICE OF THE ARTS

COUNCIL FOR THE ARTS

The Council for the Arts increased its programs this year, offering several small-scale events in other cities. The council had another record-breaking fundraising year, in both the percentage of members who contributed as well as amount raised.

Magda Fernandez, formerly of the List Visual Arts Center, joined the council staff as senior office assistant on August 1, 2000.

Council Standing Committees

The 28th Annual Meeting of the Council for the Arts at MIT, chaired by Dorothea Endicott, took place on October 26 and 27, 2000, and was focused on music. Attendees were treated to a visit to the Piano Lab, led by Professor Jeanne Bamberger, a tour of the Music Library led by Music Librarian Peter Munstedt, and a performance by the Festival Jazz Ensemble, led by Frederick Harris of the Music Section.

The Annual Meeting dinner was held on Thursday evening, October 26, at the Charles Hotel in Cambridge, at which time the Eugene McDermott Award in the Arts was presented to The CORE Ensemble (see Special Programs, below).

The Friday morning business meeting began with an address by Dean of the School of Humanities, Arts, and Social Sciences Philip Khoury, who spoke about the School's recent 50th Anniversary celebration. Introductions of and remarks from the new Chairman of the Council, Dorothea Endicott and new Vice-chair Stephen Memishian '70 followed. MIT Lecturer in Music George Ruckert and MIT student Kathak dancers offered a wonderful lecture-demonstration on Indian Music and Dance at MIT.

Martin Marks, senior lecturer, Music Section offered a presentation on his area of expertise, film music, and students from the MIT Symphony Orchestra spoke about their extremely successful European Tour, which was funded in part by the council. Finally, Associate Provost for the Arts Alan Brody gave his annual State of the Arts address, at which outgoing Chairman Martin Rosen was warmly thanked for his service.

The Gyorgy Kepes Fellowship Prize was presented to Professor Marcus Thompson (see Special Programs below) at the Annual Meeting luncheon on Friday, October 28 at the Faculty Club.

The Arts Scholars Committee (Brit d'Arbeloff, chair), the newest of the council's programs, continues to experience "growing pains" as members of the committee and council staff work to create the appropriate environment for the development of a community of student artists. This year the program got off to a very promising start with an event at the List Visual Arts Center, where Curator Bill Arning and Director Jane Farver gave those assembled a special tour of the Student Loan Collection. Other highlights include attending a performance by Philip Glass and the Kronos Quartet of Glass's new score to the 1933 film *Dracula* at Boston's Orpheum Theater, and attending the premiere of the film *Wish You Were Here* by Council Scholar Kevin Choi '01.

The Communications Committee (Pepi Weis, chair) produced three issues of the council newsletter, *Council Currents* this year, to great success. *Council Currents* is written by council members, for council members.

The Development Committee (Daniel Vershbow '45, chair) solicited unrestricted contributions averaging $4,075 from 85 council members as of 7/11/01. Five non-member donors contributed unrestricted gifts averaging $2,002. The total raised for the year (as of 7/11/01) was $356,425.

The Grants Committee (Bradford M. Endicott '49, chair) awarded a total of $80,320 in the form of 44 grants. Highlights include support for a residency by Gardzienice theater troupe from Poland, support for a film festival featuring the work of Native American women, and the visit of composer Roger Reynolds.

The Membership Committee (Bernard G. Palitz '47, chair) reported that as of July 2001 council membership stands at 107, with five *ex officio* members and 102 regular members. The following new members have joined the ranks of the council since last July: E. Verner Johnson '60, Robert Schaffer '80, and John Paul Isaacson '69.

The Special Events Committee (Catherine N. Stratton, chair) reported that on October 6, 2000, the Council co-sponsored with the MIT Alumni Club of Chicago, a small event in Chicago. Held at the law firm of Council Member Michael Rechtin '79, the council imported the MIT Festival Jazz Ensemble Combo, a group of five students who performed for a gathering of about 30 MIT alumni/ae. Associate Provost for the Arts Alan Brody introduced the group and spoke briefly about the Arts at MIT and the council.

On February 27, 2001, the council sponsored an event in Greenwich, CT at the Bruce Museum. World-renowned cellist and MIT alumnus Carlos Prieto '58, performed for the group.

The Council for the Arts enjoyed a "mini-excursion" on June 11 and 12, 2001 in Washington, DC. Approximately 22 members and friends attended. Highlights included tours of WPA murals in the Department of the Interior and Department of Justice, and the Diplomatic Reception Rooms at the Department of State. The event concluded with a gala dinner at the Kennedy Center with 200 members of the MIT Alumni Club of Washington, DC, where guests were entertained by the MIT student group, the Festival Jazz Ensemble combo, and heard a speech by Michael Kaiser, MIT Sloan School class of 1977 and newly-appointed head of the Kennedy Center.

Affiliated Committees

List Visual Arts Center (LVAC) Advisory Board (Kitty Glantz, chair) continues to be a valuable group of advisors to the LVAC Director, Jane Farver.

The MIT Museum Advisory Board (Harvey I. Steinberg '54, chair) continues to be a strong group of advisors to the Museum Director, Jane Pickering. This spring the renovation of the Museum façade was unveiled, and *Mind and Hand* and the new permanent exhibition exploring the concept of "the MIT education" opened.

The Artist-in-Residence Committee (Stephen Memishian '70, chair) is organized along the lines of the MIT Museum and LVAC Boards described above. This committee works with MIT Office of the Arts Director of Special Programs Maureen Costello and a panel of arts professionals, council members and artists to bring artists to the MIT campus to work throughout the Institute.

Special Programs

Since 1980, the council has underwritten MIT's enrollment in the University Membership Program offered by the Boston Museum of Fine Arts. This program provides free admission and discount benefits to all MIT undergraduate and graduate students, as well as ten membership cards for the daily use of MIT faculty and staff.

The free-ticket program with the Boston Symphony Orchestra continued this year. MIT students can obtain, with their student ID, free admittance to Thursday evening and Friday afternoon concerts on a day-of-show, stand-by basis. The success of this unique program continues unabated.

The successful Student Performing Arts Excursions Series continued, with tickets to the following events made available at no charge to MIT students: *Amphytrion* at the Huntington Theater, the Alvin Ailey Dance Troupe, the Bale Folclorico de Bahia, *The Water Engine* by David Mamet, *Richard II* by William Shakespeare, *Edward II* by

Christopher Marlowe, and performances by the Boston Early Music festival, the New York Collegium, Collage New Music, the Handel and Hadyn Society and a concert by the Charles Mingus Orchestra.

The Gyorgy Kepes Fellowship Prize was presented by Angus MacDonald to Professor Marcus Thompson at the Annual Meeting luncheon on Friday, Oct. 27. At the Annual Meeting dinner at the Charles Hotel, the Eugene McDermott Award was presented by Dorothea Endicott (McDermott Award Committee chair) to the CORE Ensemble, an innovative chamber group.

At the Institute Awards Convocation on May 14, Associate Provost for the Arts Alan Brody presented the Laya and Jerome B. Wiesner Student Art Awards to Laurel P. Smith (G) for music, Anand Sarwate '01 for Theater and Music, and Dawn Perlner '01 for music. The Louis Sudler Prize was presented to Thomas Lada '01 for his accomplishments in music.

More information about the Council for the Arts can be found online at http://web.mit.edu/arts/camit.all.html

Susan R. Cohen

ARTS COMMUNICATION

In the 12th year of the Office of the Arts, Arts Communication continued to maintain and increase awareness of the arts at MIT both within and outside of the Institute by publishing and distributing up-to-date information on MIT arts events and exhibitions; actively promoting arts-related activities, programs and people at MIT; and working with the Admissions Office to inform prospective students about the arts at MIT. Significant developments included the publication of a new arts brochure, work also began on the writing, design and programming of a new "arts at MIT" web site.

Internal (MIT) Activities

A new MIT arts brochure, aimed at student recruitment but usable as well for fundraising and general public relations purposes, was released and distributed both on- and off- campus.

Mary Haller, director of Arts Communication and David Freilach of the List Visual Arts Center presented a one-session class during MIT's Independent Activities Period entitled, "Getting the Word Out: Publicizing Your MIT Arts Programs and Events."

Administrative Staff Assistant Lynn Heinemann worked with the staff of Information Systems during the fine-tuning and tweaking of MIT's official electronic events calendar—joining the team for consultations on structure and design, while overseeing and maintaining arts listings.

Heinemann maintained and publicized arts events on MIT's electronic web-based Events Calendar and maintained the current web site for the arts at MIT, updating calendar listings, publishing each week's Tech Talk arts stories and creating new links as required. The LED sign in Building 16 continues to generate attention with announcements of MIT's schedule of arts events and activities, written and programmed by Heinemann.

Arts Communication continued to oversee ArtsNet, which consists of about 90 campus arts representatives, the "Arts at MIT" bulletin board in Lobby Seven and the weekly "Arts Hotline" (617-253-ARTS).

Haller represented the arts as a member of the Communications Operations Group (COG) and Information Group.

Student Recruitment And Communication

For the sixth year, MIT's admission application included tear-out postcards for prospective students to use to request information on the arts at MIT and indicate specific arts interests. Postcards and email responses were received from 1,178 individuals and a copy of the new *Arts@MIT* booklet and a "freebie" flyer were sent to each with a letter from Associate Provost for the Arts Alan Brody.

Arts brochures and event calendars were made available to prospective students who attended Campus Preview Weekend (CPW) with their families. Haller discussed the arts at MIT as part of CPW's 11-member Student Life Panel, which was attended by approximately 300 parents.

Tech Talk Coverage

For the 12th year, Arts Communication provided text and images for the weekly Arts Page in Tech Talk. Material for 21 feature Arts Pages and eight Month-at-a-Glance Arts Pages (including two two-pagers) were compiled and written by Heinemann, edited by Haller. Haller attended weekly News Office meetings and both she and Heinemann continued to work closely with its staff. Arts Page stories were posted on the World Wide Web. Copies of the Month-at-a-Glance Arts Page were mailed monthly to 594 individuals at their request.

Nineteen feature arts-related stories and 10 arts-related photos-with-captions were published in Tech Talk's general spaces, including two arts stories and three arts photo-captions on the front page. Activities and individuals involved in arts were cited five times in the "Awards & Honors" column and once in "Here & There." Heinemann was the primary writer; other contributors included Haller, members of the News Office staff and members of the MIT arts community.

Selected Media Attention

The following are some of the people and projects across the Institute who received external media attention through press releases and publicity efforts initiated by Arts Communication:

- The 50th anniversary of the School of Humanities, Arts and Social Sciences and the addition of the word "Arts" to its name;
- The Council for the Arts at MIT (CAMIT)'s presentation of McDermott and Kepes Awards to The CORE Ensemble and Marcus Thompson, respectively;
- Arnold Dreyblatt's concert at MIT;
- The CORE Ensemble's presentation of *Tres Vidas* at MIT;
- Alumnus Gus Solomons' Lecture-demonstration at MIT; and
- MIT's involvement in the 2001 Boston CyberArts Festival.

Other National Attention

The MIT Gilbert and Sullivan Players made an appearance on national television—as an answer on the October 17 broadcast of the game show "Jeopardy." The clue, "This Cambridge engineering school has a Gilbert and Sullivan Players group" was correctly answered, "What is MIT?"

The Lyric Opera of Chicago's staging of Professor John Harbison's revision of his opera *The Great Gatsby* received positive reviews. The Chicago Sun-Times' Wynne Delacoma wrote, "watching Lyric's tightly paced, beautifully polished production, it was clear that Harbison's "Gatsby" is, at its core, an intimate tale. If we surrender our expectations for grand scale and follow Harbison into its moody, quiet heart, we will find an atmospheric universe where hopes and disappointments are as piercing yet evanescent as the coastal fog off Long Island." John von Rhein of The Chicago Tribune said that "Harbison, working from his own ingenious libretto, has met the challenge with great flair, creating not a pale imitation of the novel but a worthy, independent work of art." Revisiting the work, Richard Dyer of the Boston Globe noted that Harbison's *Gatsby* "may be the most musically sophisticated opera ever written by an American composer, and some of the score haunts the memory and the imagination."

The unlikely technological pairing of film's earliest silent format with DVD, the latest in home entertainment systems proved to be a boon for Senior Lecturer Martin Marks. He composed the music and written the notes for 50 newly-restored silent films included in the National Film Preservation Foundation's set of four DVDs—"Treasures of American Film Archives"—which was called the "best set of the year" by Peter M. Nichols of the New York Times.

The National Society of Professional Engineers has a web site pointing to engineering marvels to check out while touring the U.S. Alexander Calder's *The Great Sail* ("La Grande Voile"), located in McDermott Court, is one of four listings for Massachusetts on the NSPE's new "Sightseer's Guide to Engineering" site.

The Museum Loan Network was praised for "Sharing Buried Treasure Via a Network" in the New York Times (May 2).

Joe Davis, research affiliate in the Department of Biology, found renown in major publications and broadcasts. Scientific American (April 2001) published a profile titled, "Art as a Form of Life," in which writer W. Wayt Gibbs states,"Genetic artist Joe Davis has made more copies of his work than have all prior artists combined. But there's not much of a market for artworks embedded in bacterial genomes." The Washington Post has also featured the

former Center for Advanced Visual Studies fellow (1982–92), calling him the "*éminence grise* of the 'bioart' movement." Pamela Ferdinand wrote, "Davis eschews the art versus science argument, insisting that he speaks both languages and could not possibly tear the two disciplines apart in his own mind." Ms. Ferdinand also states that collaborations between artists and scientists "give artists access to technical expertise, sophisticated resources and expensive technology," adding that "For scientists, an unorthodox presence in otherwise protocol-ridden environments can lead to new ways of approaching tasks." ABC's "Nightline" came to MIT to film Mr. Davis in his laboratory, for a story to be broadcast this summer.

Other Local Attention

Major coverage for the ongoing construction of Frank O. Gehry Associates' new Ray and Maria Stata Center for Computer, Information and Intelligence Sciences. Improper Bostonian named it "Boston's Best 2000 Architectural Project" in the July 26–August 8 issue. The magazine states, "The architectural model looks like something you'd see on a science-fiction movie set, an almost comical conglomeration of dissimilar forms... It promises to be wacky and wonderful. We can't wait."

A *Boston Globe* feature (May 20) on Boston's building boom and the emergence of "brand-name architects" featured three MIT projects: Fumihiko Maki's Media Lab addition, Kevin Roche's Zesiger Sports and Fitness Center and Gehry's Stata Center.

The List Visual Arts Center's *Global Conceptualism: Points of Origin, 1950s–1980s* was called a "richly textured, immensely thoughtful, historically important exhibit" by Christopher Millis for the Boston Phoenix, while the Boston Herald's Mary Sherman noted, "to be confronted with so many thoughtful investigations into the nature of art, is a valid exercise, worthy of an institution like MIT and its fertile environment for continued discourse, the greater Boston arena."

List Visual Arts Center's new curator Bill Arning made a local media splash with major features and interviews linked to his debut show, *Inside Space: Experiments in Redefining Rooms.*

The closing of the MIT Museum's *MIT Hall of Hacks* received major attention in the local media and MIT's brand of practical joking was covered on National Public Radio's Weekend Edition, in a March 25 story about these "diabolical pranks" featuring an interview with Assistant Safety Officer David Barber, who is in charge of dismantling the hacks from MIT's rooftops and precipices.

MIT's Artists-Behind-the-Desk exhibition, concerts and literary arts series were covered by local newspapers and media: WCVB's (Channel 5) early morning news (January 24) included a report from newscaster Ed Harding featuring the ABD graphic displayed behind the anchor desk; *The Boston Globe* Calendar Section featured the exhibition as a "Cheap Thrill" and WBZ radio interviewed Mindy Baughman, administrative assistant in Materials Science and Engineering who served as curator and artist coordinator for "New England Weekend" (January 21).

The MIT Musical Theatre Guild's Summer 2000 production of *Return to the Forbidden Planet* rated a featurein the Boston Globe's "Go!" Column (August 31) which wrote, "Our eyes moistened when we saw that the wonderfully demented souls at the MIT Theater Guild [sic] are producing *Return to the Forbidden Planet*" and the Globe's David Wildman wrote a "Pulse" feature—complete with a photo—about the MIT production.

Avant-garde trumpeter Rajesh Mehta's return to his alma mater was the subject of a feature story in the *Boston Globe's* "Jazz Notes" column (April 20). The feature was followed by a rave review (April 28) for the Raj Mehta/Paul Lovens concert, which the Globe called a "sonic sundae."

MIT's Artists in Residence were interviewed by the *Boston Globe* for question-and-answer columns. Diane Willow was featured in a "Job Explainer" column (April 29) and Arthur Ganson was questioned on his inventiveness and sources of inspiration (May 20).

Stories on the Boston CyberArts Festival featured major coverage of MIT components including performances of Professor Tod Machover's *Hyperstring Trilogy* and *Forever and Ever*; the DeCordova Museum's *Flights of Fantasy*, created by Principal Research Associate Glorianna Davenport and Media Lab students; and digital installations at MIT's List Visual Arts Center.

More information about the Office of the Arts can be found online at http://web.mit.edu/arts/.

Mary L. Haller

SPECIAL PROGRAMS

Special Programs began its 11th year of developing diverse programs with MIT departments. Music residencies with Gunther Schuller, Arnold Dreyblatt and Raj Mehta and Paul Lovens were particularly significant.

The interdepartmental storytelling and web design program with Ellen Zweig tested new modes of web interaction between students and the persona of "Lucy Anna Morel."

Artist In Residence Advisory Board

In its fourth year, the Advisory Board, under the leadership of Steve Memishian (G) ' 70welcomed new membership and reviewed the viability of its five year plan and heard from Glenn Billingsley, development officer for the Arts about the complexity of raising support. Associate Director of the Media Laboratory Professor John Maeda also spoke to the board and described a most unique process of community building through groups like the Model Railroad Builder's Club. The Board was presented with 2001–2002 artists and advised on upcoming artists and programs for the coming year.

Artist In Residence Advisory Board Subcommittee

A subcommittee met to consider the artist's participation in the celebration of the tenth year of the Residency Program. A short list of artists was made and a much discussion around artists working with students developed into a viable program idea.

School Of Humanities, Arts, And Social Sciences

Three Music Section residencies were implemented over the course of the year. Fred Harris marked Gunther Schuller's 75 years with a celebratory program; Professor Evan Ziporyn guided Arnold Dreyblatt's IAP Program of working with students, visual arts discussions and public performance and Lecturer Mark Harvey facilitated Raj Mehta's '86 and Paul Lovens' music presence on campus. Each of these Residencies involved the artists working closely with students in courses, workshops, ensembles and public performances.

The Women Studies Program, with Office of the Arts support presented "The Contemporary Arts of Africa" and invited writer and filmmaker Anne Laure Folly and Veronique Tadjo and author Tsi Tsi Dangaremba. A series of discussions and films were well moderated and attended.

Ellen Zweig, with support from the Ida Ely Rubin Fund returned to MIT to materialize *The Electric Travels of Lucy Anna Morel.* A group of undergraduate and graduate students worked with Ms. Zweig during the fall semester by bringing in personal electronic elements and objects to test Lucy's inquisitive mind and ultimately to decide her fate.

The 2000 McDermott Awardee, Core Ensemble, rehearsed and presented *Tres Vidas* a bilingual musical theater piece about the lives of painter Frida Kahlo, activist Rufina Amaya, and poet and activist Alfonsina Storni. Three Spanish language classes attended the program. Their lead actress, Georgina Corbo worked on acting technique with the Theater Section.

In collaboration with Dance Umbrella, and with MIT support from the Alan W. Katzenstein Memorial Fund, Bill Shannon, a.k.a. The Crutchmaster, offered insights on hip hop and living with a disability. With a wry sense of humor, he bedazzled us with his live and filmed skateboard movements.

The Robert Muh Award was given to alumnus Gus Solomons, choreographer and writer during the 50th Anniversary of the SHASS in October. Mr. Solomons returned to MIT for a Spring Residency attended by Mr. and Mrs. Robert A. Muh. Mr. Solomons was awarded a plaque of excellence by Associate Provost for the Arts Alan Brody.

School Of Architecture

Diane Willow, sound and environmental artist, completed her second year as Artist in Residence in collaboration with Professor Mitchell Resnick of the Epistemology and Learning Group of the Media Laboratory. *SEAt* was dismantled and moved to storage in Somerville while new installation locations were sought. Ms. Willow conducted

a successful IAP Program and worked with several groups of students during this past year. She continued the leaf animation development of The Arbor. Development trips were made to Japan, Ireland, California, and Maryland.

Diller & Scofidio, 1999 McDermott Award Recipients and interdisciplinary architects, participated in architecture studio visits and discussed The Blur Building in "Non-Sequiturs" the Architecture Lecture Series. They also worked with the Theater Section in a specially convened course.

School Of Engineering

Kinetic sculptor Arthur Ganson worked with and visited many individual students and groups at MIT. He has been particularly inspired by the research at the Artificial Intelligence labs.

Felice Frankel, a science photographer based in the Department of Electrical Engineering and Computer Science, in partnership with Boyce Rensberger, director of the Knight Fellowship, conducted a conference on "Image and Meaning: Communicating Science and Tecnhology" from June 14–17. A photographic exhibition of work in the Sala de Puerto Rico inspired attendees to confront the importance of creating compelling images to make science accessible to any audience.

The List Fellowship Program In The Arts

The List Foundation Fellowship Program in the Arts for Students of Color continued with new support from the John S. and James L. Knight Foundation.

Kevin Choi '01 screened *Wish You Were Here: A Video Documentary* on coming of age and self discovery filmed during Mr. Choi's recent travels in Europe, where he creatively examined his gay and Chinese identities.

Helen Lee '00 displayed *Blanket*, a mixed media installation of hand blown glass bones, strung and woven into a blanket. Ms. Lee presented two gallery talks about the evolution of Chinese naming practices, her grandmother's death and her substantial interest in glassblowing.

Two fellowships were awarded: to Talia Kingsbury '01, mechanical engineering and creative writing, for the development of an interactive digital narrative titled *Origines/Destinations*; and to Vince E. Carballo '02, mechanical engineering, to develop a mixed media installation titled *Lost Sons*. Both projects will be completed in November 2001.

Plans were begun for a tenth year celebration.

Institute Committees

Five year participation on The Committee on Campus Race Relations and Subcommittee for RACE 2000! and RACE: The Future! ended in December 2000. A substantial history of race relations programming was left to the Committee and Subcommittee.

More information about Special Programs in the Office of the Arts can be found online at http://web.mit.edu/arts/specprogrs.all.html.

Maureen Costello

DEAN FOR UNDERGRADUATE EDUCATION

The past year started with important organizational changes for the Office of the Dean for Undergraduate Education (DUE). In July 2000 the DUE office became distinct from the Office of the Dean for Student Life (DSL); previously both had been part of the Office of the Dean for Students and Undergraduate Education (ODSUE). With this change, Professor Rosalind Williams completed her 5-year term as ODSUE Dean. Professor Robert P. Redwine became Dean for Undergraduate Education, and Dr. Larry G. Benedict became Dean for Student Life.

While the DUE and DSL offices are now organizationally separated, there is a strong commitment across the organizations to work together on the many issues involving student life and learning. To promote this close collaboration, the two Deans' offices, along with that of Senior Associate Dean Robert Randolph, are now co-located in the 4-110 suite. There are also important administrative connections between DUE and DSL, including, for example, our joint process for awards and recognition.

With the new organization and new leadership, the Office of the Dean for Undergraduate Education had a very exciting and productive year. The summary below discusses the highlights; many more details are contained in the office summaries which follow.

ORGANIZATIONAL CHANGES

At the beginning of this year, Elizabeth Hicks joined DUE as Director of Student Financial Services (SFS). Hicks immediately began to make her mark, re-organizing personnel and activities to make SFS more responsive and efficient in its mission to support our students in reaching their educational goals. DUE, with the strong support of the Provost's and Chancellor's Offices, is providing considerable financial resources to assist Hicks in her make-over of the SFS.

The importance of serious assessment and evaluation of initiatives in education has become very clear in recent years. Such assessment should be part of the design of initiatives and not just be attempted after-the-fact. An important center at MIT for assessment and evaluation has been the Teaching and Learning Laboratory (TLL), directed by Lori Breslow. In the past year we have brought TLL into DUE as a full-fledged office and are in the process of strengthening the group and physically locating TLL near other DUE activities in the main group of buildings. The assessment and evaluation activities of TLL are already having important impacts on the projects funded by the d'Arbeloff Fund and by iCampus.

Significant organizational changes involving the Registrar's Office, the Office of Academic Services (OAS), and senior personnel Mary Callahan, Margaret Enders, and Kim Vandiver took place this year. Early in the year it was decided to agree to Mary Callahan's wish to concentrate on being Registrar, thus giving up the co-directorship of OAS. Dean for Undergraduate Research Kim Vandiver was asked to co-direct OAS with Associate Dean Margaret Enders.

In the past year, DUE has played a leadership role in the development of the Cambridge/MIT Institute (CMI). The Dean is the MIT Program Director for Undergraduate Education and Student Exchange in CMI. Assistant Dean Margaret Enders and Associate Dean Kirk Kolenbrander have led successful efforts within DUE to implement the student exchange program, and several DUE and DSL offices contributed significantly to these efforts.

We were pleased this year to host Professor Gordon Weil, Associate Provost of Wheaton College as an ACE Fellow. Professor Weil's wisdom, good humor, and many contributions were much appreciated.

Some specific offices within DUE have made important progress in increasing the diversity of their staff. This is important not just for the individuals and offices involved, but also for our capability to serve and support a diverse student body. Other offices within DUE will receive more attention in this regard in the coming year.

HIGHLIGHTS OF DEVELOPMENTS AND INITIATIVES IN UNDERGRADUATE EDUCATION

It is important to emphasize that the recent report of the Task Force on Student Life and Learning continues to be a guide for many activities in DUE. We are strongly committed to the goal of establishing community, along with classroom teaching and research, as a critical third leg of an MIT education. We are especially concentrating on working with DSL to use new housing opportunities to enhance the overall education of MIT students.

As described above, our activities in CMI have so far concentrated on establishing the undergraduate exchange program. This is moving along very well, with 25–30 students from each university expected to participate in the fall of 2001. We expect to spend more effort in the future on helping to establish joint courses with Cambridge.

It is critical to the success of DUE's mission that we work in conjunction with the faculty and students on programs and initiatives. A primary vehicle for this collaboration is the Committee on the Undergraduate Program (CUP). In the past year there has been especially close collaboration with CUP on several issues.

One of these issues is implementation of the new Communications Requirement (CR). The CUP Subcommittee on the Communications Requirement, with much help from DUE, has led the effort in the past year to bring the schools

and departments to the point where the CR can be implemented with the class entering in 2001. This effort has gone very well, although there is much additional work to be done before the departments see the full implications of the requirement in 2003. Changes in DUE related to the CR, especially in the Registrar's Office, are well along. We are in the process of hiring a CR Coordinator for DUE; this person will provide coordination of many aspects of the CR across the Institute.

Another joint CUP/DUE project in the past year has been developing and shepherding the Pass/No Record change proposal through the approval process. We are now working on the changes necessary to have it in place for the class entering in 2002.

It is very important that DUE have an appropriate role in realizing the many opportunities provided by new technology for education. The best role is likely that of serving as a bridge between the new initiatives involving technology and the more mainstream efforts in education by our faculty and departments. To accomplish this the Dean for Undergraduate Education now serves as co-chair (with Provost Bob Brown and Professor Hal Abelson) of the Council on Educational Technology. This connection has proven critical to providing support from DUE for initiatives, such as OpenCourseWare.

The past year has seen the first full year of projects funded by the d'Arbeloff Fund for Educational Innovation and the second annual competition for new funding. By all accounts this program is extraordinarily successful, both in terms of invigorating the campus in this critical area and in terms of starting efforts which promise to be part of long-term changes in undergraduate education at MIT.

As described above, the Teaching and Learning Laboratory is now providing important resources and leadership for assessment and evaluation of a wide variety of educational initiative on campus.

Six new MacVicar Faculty Fellows were named this year: Mary C. Boyce, Anne Mayes, David A. Mindell, Heidi M. Nepf, Janet Sonenberg, and J. Kim Vandiver. The new Fellows were announced at a luncheon at the March Corporation meeting. This occasion was also MacVicar Day, at which several new activities in active learning were presented and discussed.

The Enrollment Management Group, chaired by the Dean for Undergraduate Education, met several times to decide on recommendations to Academic Council on tuition and financial aid policy for next year. The highlight of the recommendations and the eventual decision was a significant reduction in the "self-help" level. This change should provide important financial and educational benefits for many of our students.

We continue to work with the Development Office to secure funding for important initiatives and programs. The UROP program received significant additional funding this year, for example. We are actively seeking to endow as much of the Communications Requirement costs as possible.

ADMISSIONS OFFICE

The goal of the Admissions Office is to identify, recruit, select, and enroll the best students in science, engineering and technology in the world. We continue to have great success despite increasing competition and a wildly fluctuating marketplace, primarily due to the changing financial aid policies of our major competitors. Though our yield has dropped slightly because of this, we still hold the #5 position among our competitors. The main themes this year in Admissions are the following:

- The Institute increased its financial aid to needy students by decreasing self-help and changing a few internal policies regarding family assets. This helped us in our yield process, though not as well as hoped since our competition (Harvard, Princeton, Stanford, Yale) also made their financial aid more desirable. In addition, we have worked more cooperatively with Student Financial Services to deliver a smoother admissions process.
- We switched more of our publications and communications to the Web.
- We continued the reorganization of the Educational Council Office to provide an increased, more effective alumni presence in the admissions process.

ADMISSIONS STATISTICS

- Our freshman applications were down one percent to 10,495 due to decreased number of internationals.
- The freshman yield rate is 58 percent, or 1039 enrolling, down one percent from last year.
- The enrolling freshman class will include 42 percent women, 18 percent minorities, and a record 10 percent students designated "academic superstars." Forty-five states are represented, all but Alaska, Arkansas, Idaho, Mississippi and North Dakota. International students are citizens of 45 countries, though if U.S. Permanent Residents were included, 60 countries would be represented in the class.
- The freshman admit rate was 17 percent, the second smallest applicant-to-admit ratio in MIT's history.
- We will enroll 33 transfer students and enrolled 6 this past spring to total 39 enrolling for the year. The admit rate was 13 percent, the yield rate is 85 percent (compared to last year's figures of 17 percent admit rate and 78 percent yield).
- Graduate applications were down 13 percent to 10,253. Overall admit rate was 24 percent. The yield is up slightly to 57 percent from 56 percent last year.

Currently there are a record 1956 Educational Counselors (ECs) representing 50 states and 54 countries. Twenty-six percent (509) are female and 4 percent (74) are minorities. ECs interviewed 95 percent of all applicants. ECs arranged 93 central recruiting meetings for admissions staff around the US in 83 cities last fall attended by over 11,000 people. They also sponsored 61 admitted student receptions this spring and 9 enrolling receptions this summer.

SUCCESSES

We were able to document a direct correlation between our admissions numeric index and future MIT GPA. As a result we made a change in how we admit undergraduates, and this year's CAP studies confirm that we are admitting fewer students who are likely to have academic trouble. This year, as in last, 2 percent of the admitted group had numeric indexes in the lower half of the pool. This means that this entering freshman class has the highest overall numeric index on record, and therefore, should be most likely to do well at MIT.

It was an extraordinary year for minority freshman admissions. We had a 19 percent increase in minority freshman applications, the highest on record at 887. This includes record high applications from African American and Mexican American students. The admit rate of 34 percent is an all-time low for MIT (low admit rates are good), down from 40 percent last year and from the 55 percent range of the 1990s. This means that we are attracting a larger pool of qualified applicants and can afford to be more selective. We also have the highest minority yield ever at 62 percent, 3 percentage points higher than our overall yield. It is important to note that these students are well within the top half of the numeric index of our admit group, the strongest class in MIT's history. Among our peer institutions, we have the 2nd highest yield for African Americans after Harvard, and the highest yield for Mexican Americans.

We had the greatest faculty involvement in admissions in the 22 years that I have been in the Admissions Office. We more than doubled the number of faculty readers and their attendance at selection, though the numbers are still small (30 faculty).

We worked hard to expand our web presence:

- We completed the first two stages of our admissions web site redesign.
- We chose one vendor (CollegeNet) for both grads and undergrad admissions to provide an electronic application that will be directly downloaded into our database.
- We expanded electronic application status-checking for Educational Counselors. ECs can now look up the decisions on their interviewees as well as the quality ratings of their reports.
- Out of desperation Admissions shut off its email operation last summer, but we have now secured an email system through CollegeNet that makes email easier to answer and which, incidentally, is free.

Once again we held the Campus Preview Weekend for all admitted prefrosh this year. Fourty-seven percent of the class chose to attend (42 percent last year) and 71 percent of them have chosen to enroll this fall (73 percent yield last year). Campus Preview Weekend is our top yield event, as well as being one of the few events that pulls the undergraduate communities together.

Nearly all of the graduate departments now use the graduate admissions database. We have helped several departments analyze their yields as well as design their cancellation studies. And as of this past July 1, the graduate application is now electronic.

More information about this department can be found online at http://www.mit.edu/admissions/.

Marilee Jones

OFFICE OF ACADEMIC SERVICES

ACADEMIC INFORMATION AND COMMUNICATION

As part of a comprehensive review of undergraduate advising being undertaken by the Office of Academic Services (OAS) to complement the work of the Committee on the Undergraduate Program, a Discovery Team on Advising at MIT was formed to explore ways to improve information flow to and from undergraduates and their advisors. The team's recommendations included a wish list of features for an online augmented advising system based on feedback from faculty, students and staff; and a plan for coordinated content delivery that is presented from the users' points of view rather than on the basis of organizational structure.

The team's recommendations were based on interviews with students, faculty, and staff, as well as on best practices identified in other universities and in business. The final report and background information of the discovery project are available at http://web.mit.edu/is/discovery/advising/. Sponsors of this project included the CUP and the Dean for Undergraduate Education; all sponsors have enthusiastically endorsed the recommendations, and implementation is underway.

Work also continued throughout the year with members of the Academic Resource Center to plan and create a new "First Year" web site with both improved navigation and content. The site went live at the beginning of May.

THE ACADEMIC RESOURCE CENTER

The Academic Resource Center (ARC) has spent this year systematically evaluating all programs and initiatives, and resource allocation, and assessing new programmatic needs necessary to support and facilitate the success of academically at-risk students, under-represented minorities, athletes, and other populations within the freshman class. Follow-up of students flagged in the 5th week has been instituted; end-of-term outcomes have been followed.

New and expanded opportunities were initiated this year to provide collaborative relationships with other offices within the two new Dean's offices and the departmental undergraduate academic administrators. Efforts are underway to further develop opportunities to collaborate with the Office of Minority Education.

Orientation

Four student coordinators led the Orientation '00 Committee and 108 upper classmen were involved as orientation leaders. Thirty percent of the incoming class participated in five pre-orientation programs (Leadership, Outdoors, Ocean Engineering, Arts, and Urban programs). The residence Midway allowed students to investigate housing options without leaving campus.

Successful and varied programming that was continued included a presentation by Jay Friedman regarding alcohol and relationships; a health and wellness fair; and programming focusing on underrepresented minorities, women's, and LBGT's issues. Twenty-five volunteers complemented the student coordinators, leaders and staff.

Specific programs were offered to transfer students and there was a separate dinner for these students. Thirty-five transfer students entered in the fall of 2000, and six in the spring of 2001.

Freshman Advising

Ninety-three freshman advising seminars were offered, and there were sixty-five traditional advisors. Recruiting faculty to be freshmen advisors remains a challenge. Faculty represented 53.8 percent of the freshman advisors. The advising cadre included 85 faculty and 73 administrators and staff. There were 210 associate advisors. Expanded professional development opportunities were offered to both advisors and associate advisors.

A new pilot program in Residence-Based advising, supported by a d'Arbeloff grant, was implemented in the fall of 2000. The advising pilot represents an effort to create freshman advising communities that incorporate academic support with upper-class student mentoring and student life programming through the living group. Sixty-eight women in McCormick Hall were advised through six seminars and with two traditional advisors. Assessment indicators are positive thus far, and a final assessment is underway.

Independent Activities Period (IAP)

During IAP 2001, 547 different non-credit activities were available to the MIT community. Additionally, 100 for-credit subjects were taught during this period. Both on-line submission of offerings and the on-line *IAP Guide* were very effectively accessed and used. Printed *IAP Guides* were reduced by 3000 copies to 12,000 duplicates.

Publications and Web

The ARC has eliminated a number of publications or reduced them to brochures with an extensive listing of web addresses. Information is focused on four cyclic homepages, timed for the student's progress within the academic cycle. In addition, large publications which quickly become outdated, such as the *UROP Directory*, are available on-line, but are complemented with a small summary brochure.

Undergraduate Research Opportunities Program

During summer 2000 and academic year 2000–2001, a total of 1832 students conducted 2862 UROP projects. There is a slight increase in both the number of projects (2819 vs. 2862) and the number of participants (1758 to 1832) compared to last year. In AY2000–2001, 70 percent of the students chose UROP for pay, 28 percent for credit and 2 percent volunteered. During the summer, with the exception of two students, all UROP students conducted their projects for pay.

Presently, the UROP book-value endowment exceeds $8.4M; the Paul E. Gray Fund for UROP is the largest of the Program's individual endowment funds. Increased income from the endowment, combined with gifts and Institute funds, allowed the UROP office to allocate $954,000 to students. Additionally, faculty allocations to students through sponsored research or departmentally managed funds reached $5,415,000.

UROP's IAP Research Mentor Program continues to be a highly effective means of preparing freshmen for UROPs. Throughout the four-week program, experienced UROPers provided guidance to freshmen while working on their ongoing projects. This year thirty mentors collaborated with forty-one "pre-UROPers"; 54 percent of the participants went on to their own projects in the spring and/or summer of 2001.

ARC Programming and Outreach

A number of activities and programs were undertaken to enhance and support the academic success of students and facilitate interaction among faculty, staff and students. Notable activities include academic programming associated with the residence-based Advising Pilots; the organization of peer Choice of Major programming within residences;

the introduction of an alumni panel during the Choice of Major fair and an IAP activity (co-sponsored with Human Resources) to assist students in making confident decisions about major choice.

Support to the Committee on Academic Performance

Table 1. Summary of CAP and ARC actions for freshmen over the past five years

Academic Year	Required Withdrawals	CAP Warnings	ARC Letters	Total Actions
2000–2001	9	137	196	342
1999–2000	5	133	113	251
1998–1999	6	158	89	253
1997–1998	5	175	146	326
1996–1997	16	196	99	311

The increased number of ARC letters in 2000–2001 is due to a change in the minimum number of units which triggers such a letter.

CURRICULUM DEVELOPMENT AND FACULTY SUPPORT

Alumni Engagement

As a new strategic direction for MIT, the Council on Educational Technology (CET) chartered a team in summer 2000 to assess and recommend how MIT will harness the experience and intellectual curiosity of alumni by drawing them into the core educational experience of students. Following on the team's work and recommendations, the CET and DUE asked the OAS to take responsibility for the continued exploration and development of alumni engagement activities at MIT. Activities this year have targeted support to d'Arbeloff funded programs, including "Mission 2004" (18 alumni were matched with ten student teams); BioMatrix (33 percent of the mentors are MIT alumni); "Factories and Laboratories" (we helped identify alumni working in both senior and junior roles); and "Exploring Black Holes" (12 alumni have been selected to participate in this experimental class). In addition, the Graduate Student Council and the Undergraduate Association, working closely with and supported by the OAS, submitted in the spring a funded proposal for several projects that will bring together students, alumni, and faculty. The OAS has been working closely with the Alumni Association on these programs and would like to acknowledge their support.

Cambridge-MIT Institute Undergraduate Student Exchange

Staff within the OAS are involved with a number of the Undergraduate Education activities associated with the new Cambridge-MIT Institute. In particular, OAS has assumed responsibility for the planning and support of the undergraduate student exchanges between academic departments at MIT and the University of Cambridge. During this academic year, nine MIT undergraduate students attended the University of Cambridge from three engineering departments. The program has been expanded to include seven departments in engineering and science; in addition, we are working closely with faculty and staff in the School of Humanities and Social Sciences as we develop an exchange program that will meet the needs of our students in terms of their overall program.

Colloquium and Seminar Support

We provided assistance to the Dean for Undergraduate Education in the production of the IAP 2001 Spark Forum lecture series and of an MIT Colloquium. The topic of the Colloquium was "National Security, Civil Rights and Politics: Lessons Learned from the Wen Ho Lee Case," and involved a number of speakers from MIT and elsewhere.

d'Arbeloff Fund Educational Support

The OAS provided considerable support during the complete proposal development and review process, culminating in the distribution of awards to the 15 projects that have been funded for 2001–2002. In addition, significant administrative support was provided to a number of projects funded for 2000–2001, including "Mission 2004" and the BioMatrix mentoring project.

Faculty Governance

We continue to provide significant support to the Committee on the Undergraduate Program; in addition, this year staff support was dedicated to supporting the considerable efforts of the Pass/No Record Grading and AP Credit Subcommittee. An implementation team has been formed, led by staff in OAS. Finally, OAS provides assistance to the Chair of the Faculty in the screening of student complaints about term regulation violations.

Scholarships and Fellowships

This year the OAS provided administrative support and oversight to a number of scholarship and fellowship programs. Also, for the first time the OAS provided administrative support to MIT's chapter of Phi Beta Kappa. We inducted 61 seniors into our chapter of the honor society and held an awards ceremony with a lecture by Prof. Morris Halle, Institute Professor Emeritus of Linguistics.

Subject Evaluation

We are reviewing the results of the online subject evaluation efforts in Course 16 as we examine the feasibility of introducing a similar option to all academic departments.

Who's Teaching What
All MIT academic departments, with the exception of Electrical Engineering and Computer Science, are now contributing to the Who's Teaching What (WTW) data collection effort. This collaborative effort between OAS and Student Services Information Technology (SSIT) is motivated by the need to respond in a systematic and complete manner to the increasing requests for information about who is teaching our students – and at the same time have data available for numerous other institutional needs.

PERSONNEL
New staff in OAS include: Leslie Bottari, Administrative Assistant; Mary Camerlengo, Staff Associate, Academic Performance; Nancy Crosby, Administrative Assistant; Andrew Eisenmann, Associate Dean; Cecilia Marra, Technical Support Analyst; Julie Norman, Associate Dean, Academic Resources and Programming; Dauri Rosenfield, Administrative Assistant; and Eric Thorsen, Administrative Assistant.

Donna Friedman was promoted to Assistant Dean, Freshman Advising and Academic Services. Melissa Martin was promoted from Administrative Assistant to Staff Associate, UROP.

Three staff members left the office: Van Chu left MIT to join the Peace Corps; Margaret Devine-Sullivan is now assistant director of academic programs in the Sloan School; Leonard Lu has become an analyst programmer in Student Services Information Technology.

Peggy Enders, Kim Vandiver

OFFICE OF CAREER SERVICES AND PREPROFESSIONAL ADVISING

The Office of Career Services and Preprofessional Advising's (OCSPA) mission is to help students to learn about the relationship between what they do at MIT and life after graduation; to develop the competencies required beyond technical knowledge; to make informed decisions about career goals and to find opportunities related to their professional objectives; and to contribute to civilization. Career development is an ongoing process that includes: self-assessment, career exploration, choice of major, competency development; networking, informational interviewing, mentoring, internships, summer jobs and other opportunities to gain experience in fields of interest; study abroad; and preparation for the job search, and graduate/professional school application process, and productive, rewarding lives. Above all else, it is a generative process, which provides a foundation for achieving goals throughout life. OCSPA provides career development for students beginning with freshmen and first-year graduate students through individual one-to-one counseling, and a series of coordinated programs including a sequence of workshops and seminars.

MAJOR ACCOMPLISHMENTS
Career Development
OCSPA staff continues to maintain high levels of career development service to students, including more than 2353* office visits, and, while the number of appointments, 1460 (-10 percent), was down, the number of students coming in during "Walk-In Hours", 893 (+33 percent), was up significantly, as was the number of students attending workshops, 3519 (+60 percent). Staff also provide extensive advice to students and alumnae/i increasingly by email. Office visits included 1269 (54 percent) undergraduates of whom there were 331 freshmen, 287 sophomores, 214 juniors, and 305 seniors; 775 (33 percent) graduate students of whom there were 391 masters students, 313 doctoral students, and 66 post docs. OCSPA also saw 228 alumni and 81 employees and others. The following tables detail this level of activity and which MIT students are utilizing our services.

Table 2. Office Visits* by School

School	FY2001	FY2000
Engineering	1200	764
Science	530	429
Architecture and Planning	168	104
Management	123	230
HASS	103	53
LFM	7	--
Whittaker College	3	--
None Indicated	132	--
Undeclared Freshmen	87	44
Total	2353	1624

* As a result of improved record keeping systems this data on office visits is now reported for the fiscal year while in the past it was reported for the academic year.

Table 3. Workshops Offered and Student Attendance

	Workshops	Attendees
Basic Workshops	42	477
Graduate Students	6	173
Special Presentations	20	1290
Engineering	19	752
Science	12	340
Architecture	6	403
HASS	3	50
MGMT	1	18
DUSP	1	16
Total	110	3519

Through our school-based teams OCSPA staff meet with many departments to provide help in a variety of ways including: participating in events for prospective, incoming and current students; developing of career information for their departmental website; collaborating on developing internship and other programs which provide professional opportunities to their students; and providing information about the post-graduation destinations of each school or department's graduates.

OCSPA continues to seek to integrate the educational experience with a career development focus for learning through our Comprehensive Student Plan for Career Development. The plan offers a developmental framework for our programs, such as F/ASIP and Career Services For PhDs and Post Docs. OCSPA workshops are offered in settings across campus including residence halls and for various groups of students. The capacity of the OCSPA website also continues to be expanded to incorporate interactive portions that encourage and support student learning on-line.

Research Activity
1396 (63 percent) of the June 2001 graduates responded to the fourth annual OCSPA Survey of Graduates as they picked up their caps and gowns. Earlier response rates were 45 percent in 2000, 63 percent in 1999, and 83 percent in 1998. The survey data contains information about the demographics of the sample, their post-graduation plans, salary, career resources used, career planning, graduate school information and employment information. The survey has attracted considerable interest from schools and departments as useful outcomes assessment and as a planning tool. The data also help students learn about the relationship between what they do at MIT and life after graduation.

Freshman/Alumni Summer Internship Program
A cornerstone of our Comprehensive Student Plan for Career Development, Freshman/Alumni Summer Internship Program (F/ASIP) offers first year students the opportunity to experience self-assessment, career exploration and strategic implementation of career planning. 164 (+13 percent) students enrolled in the program, and 81 of them landed internships in 19 states and in China and Poland. The statistics are outstanding, as about 20 percent of the pre-negotiated F/ASIP internships were cancelled early in the recruiting cycle due to the downturn in the economy. We worked with the Alumni Association, the Industrial Liaison Program, and the Office of Corporate Relations to identify opportunities and alumni at various companies including start-ups, large corporations, government agencies and research organizations. Students are working on a variety of projects, making valuable contributions to society as well as to their employers. For example, one student is working on counteracting the block that the Chinese government puts on the Voice of America radio and Internet programs. Through a targeted mailing to incoming students and a more visible marketing campaign in the fall, and continuous program improvement we hope to increase the number of students who participate in F/ASIP to 300 in FY2002. To date, the demand for internships consistently exceeds the number we have available. We will strive to balance the supply and demand for internships next year.

Preprofessional Advising
In 2000, there were 168 degree and 6 non-degree, applicants to medical school, 174 in all (+2 percent), far more than the only 99 who applied in 1988. Eighty-one percent of the seniors were accepted; 57 percent of graduate students; and 59 percent of alumni/ae. There were a total of 50 pre-medical advisors: 21 MIT and MIT-Harvard HST faculty members, 27 physicians, one former dean at the Academic Resource Center, and the former director of OCSPA. MIT remains an excellent choice for premedical studies and, despite higher criteria for acceptance, our students continue to do well. Key initiatives continue to be recruiting more Pre-Medical Advisors, advising undergraduates, graduates, and alumni/ae; developing an online database, which when completed, will provide 24/7 access to student information; benchmarking with other undergraduate institutions in order to determine best practices and continue ongoing quality service improvements in MIT Pre-Medical Advising System; building effective ongoing communication with Pre-Medical Advisory Council, Pre-Medical Advisors, Pre-Medical students, MIT-AMSA chapter, and MIT-BUSA chapter.

Employment Recruiting
Over 650 employers participated in OCSPA's on-line, web-based employment recruiting program, InterviewTrak delivered in partnership with Monstertrak. Through this system, students, alumni/ae, and employers were able to communicate with each other throughout the job search process twenty-four hours a day and seven days a week.

Employers posted jobs, students reviewed the job-postings and sent resumes over the Internet, and together they were able to build interview schedules. Currently 10,716 students and alumni/ae are registered with OCSPA including 6,051 undergraduates, 2,945 Masters, 108 MBAs, 1,461 Ph.D.s, and 151 Post Docs. Employment recruiting is scheduled to almost full capacity for Fall 2001, which indicates that there will be a high volume of activity in the fall and again a taper in the spring. We will be monitoring this situation for effects of the slowing economy on our students.

Career Services For Masters, Ph.D.s, and Post Docs
These new initiatives include the development of a comprehensive professional development program especially for Professional Masters students, and for PhDs and Post Docs from all departments. These are new efforts to specialize in understanding and serving the career needs of these students. Many other professional schools and research universities, including Caltech, Penn, Chicago, Princeton, Yale and Harvard have specific career advisors who serve these students. During the spring term 2001 a new workshop on was developed and presented in conjunction with a program sponsored by the Graduate Student Council. A four-session summer transition group for Ph.D.s who are preparing for the move from student to professional was also offered. Nearly 70 students responded to the announcement of this program, which was intended as a pilot program for about 8 students, we will offer two sections, accommodating a total of 30 students.

PERSONNEL
In conjunction with the staff OCSPA reallocated staff resources to better serve the students who seem to most need our services. Specifically this plan allocated staff to students in more equitable ratios, and provided additional resources to Preprofessional Advising. Diversity of full-time staff at all levels has also increased significantly, 7 of 15 staff or 47 percent are people of color.

Deborah Liverman, Career Development Counselor for the School of Engineering and an African American woman was promoted to Assistant Director for the School of Engineering.

Ricardo Bianco, Graduate Assistant/Career Assistant for the School of Engineering and an Hispanic man was promoted to Career Development Counselor for the School of Engineering reporting to Deborah Liverman. Ricardo also assists Pre-Medical students in the School of Engineering.

Deborah Rosencrans, Assistant Director for the School of Engineering and an Asian American woman now serves as Assistant Director for the Architecture, EECS, Civil and Environmental Engineering, and Media Arts and Sciences.

Hannah Bernstein, Assistant Director for the School of Science is now responsible for Ph.D.s and Post-Docs.

Jason Wall was hired as Assistant Director for Employer Relations, and also works with DUSP.

Alisa Tongg, Career Development Counselor for Architecture, EECS, Civil and Environmental Engineering, and Media Arts and Sciences, and an Asian American woman was promoted to Coordinator of the Freshman/Alumni Summer Internship Program.

Marilyn Wilson was hired as Career Development Counselor for the School of Science UG, and will also assist Pre-Medical students from the School of Science.

Bonnie Walters, recently retired from OAS, was hired as a consultant premedical advisor responsible for recruiting premedical advisors and advising undergraduates, graduates, and alumni/ae.

Shonool Malik was hired as Assistant Director for Preprofessional Advising, Management UG, SDM, LFM, and Study Abroad. Shonool is an Indian woman.

Tamara Raimundi Menghi was hired as Career Development Counselor for Architecture, EECS, Civil and Environmental Engineering, and Media Arts and Sciences, and an Hispanic woman, and will also assist Pre-Medical students in those departments.

All new professional staff have career development experience, and have, or are pursuing master's degrees.

In addition, OCSPA staff contributed significantly to a number of MIT initiatives including the Human Resources Diversity Initiative, Dr. Christopher Pratt and Deborah Liverman; the Dr. Martin Luther King, Jr. Breakfast, Deborah Liverman; and the Council on Work and Family, Elizabeth Reed.

More information about OCSPA is available on our web site: http://web.mit.edu/career/www/.

Christopher Pratt

OFFICE OF MINORITY EDUCATION

Over two and a half decades ago, the Massachusetts Institute of Technology established the Office of Minority Education (OME) to provide academic and personal support to minority students who attend MIT and pursue a degree in Engineering or Science. The establishment of the office was a clear sign of MIT's commitment to minority students and its desire to ensure their success in achieving their academic goals. Over the years, the Institute has implemented several academic enrichment programs to support and develop minority students' intellectual capability to handle the academic rigors of MIT. Over the past four years, MIT has reaffirmed its commitment to guarantee the presence and, where possible, to provide academic enrichment programs to ensure the success of minority students who decide to attend MIT.

To that end, the mission of the Office of Minority Education is to provide effective academic enrichment programs to enhance matriculation, promote higher retention and greater excellence in underrepresented minority (African American, Mexican American, Native American and Puerto Rican/Hispanic) students' academic and general educational achievements, and to encourage their pursuits of higher degrees and professional careers. OME's mission embrace a strategy to address academic and graduation gaps between underrepresented minority and non-minority students on MIT campus.

ACADEMIC YEAR IN REVIEW AND ACCOMPLISHMENTS

Project Interphase

Project Interphase (PI) is one of the significant programs that illuminate MIT's commitment to ensure minority students academic success. The program admitted fifty-seven students which constitute approximately one-third of the admitted underrepresented minority student class. It is a seven and half week rigorous academic experience involving a curriculum that covers physics, calculus, chemistry, writing, physical education and a number of co-curricular activities.

Each year, the OME hires an academic staff that includes faculty and instructors who, with the assistance of graduate and undergraduate students, make up the teaching core for Project Interphase. Professor Nihat Berker served as the Academic Officer and through his leadership the faculty and tutors made significant contributions in preparing the participants of PI '04 to face the rigors of MIT. As a result the PI Class of 2004 received the lowest academic warnings (5) in the history of the program. Reducing the number of academic warnings participants of PI receive has been a goal of the OME leadership for seven years.

The ethnic and gender breakdowns of the PI Class of 2004 were consistent with previous years and closely reflected the underrepresented minority class of 2004. There were twenty-three African Americans, or 40 percent. Mexican Americans represented 28 percent or 16, while Puerto Rican participation increased to 12 percent, numbering 7. PI '04 saw an increase in the number of Hispanic surnamed students to 14 percent. Hispanic surnamed students are individuals who are not part of the Mexican American or Puerto Rican cohorts. Native Americans participation remains the lowest of all groups at 5 percent. This year, women representation in the program was 32 percent, slightly lower than the representation in the overall freshmen class.

Academic advancement continues to be one of the goals of PI. To that end, a high percentage of the students who took the advanced standing test for 18.01 received credit. Thus, they were able to take higher level math classes during the first semester. Several students passed Phase I of the writing requirement. In addition, we observed an increase in the number of students who passed Chemistry in the first semester. These positive outcomes reinforce the value of Project Interphase.

Seminar XL

Seminar XL is an academic enrichment program for first-year underrepresented minority and non- minority students. The students are divided into small interactive learning/study groups focusing on calculus, chemistry, physics, and other freshmen core courses offered in the fall and spring. XL facilitators, who are upper class and graduate students from a broad range of disciplines and ethnic backgrounds, coordinate the study groups and the interactive discussion of materials covered in the subject. Seminar XL utilizes an array of facilitators from a broad range of disciplines and ethnic backgrounds. All facilitators were interviewed, hired and trained by the Associate Dean/Director, in conjunction with the Assistant Dean/Assistant Director. Eighty-two minority and non-minority students enrolled in Seminar XL for the fall and spring terms that covered 8.01, 8.01L, 8.01X, 8.02, 18.01.18.02, 5.111, 5.112, 5.60 and 6.001. The majority of the students who participated in Seminar XL passed the core curriculum of the freshmen year.

Tutorial Service Room

The Office of Minority Education's Tutorial Service Room (TSR) provides tutorial service to a significant number of minority and non-minority students. The TSR is managed by a core of upper-class students who are supervised by the Assistant Dean/Assistant Director of the OME. The OME employed over fifty upperclass and graduate students from an array of ethnic backgrounds to tutor in over fifty courses. The Associate Dean/Director, in conjunction with the Assistant Dean/Assistant Director, interviewed, hired and trained all tutors, whose academic records were verified to make sure that they met the academic requirements of B or better in the courses they tutored. TSR provided academic support for 750 students during the fall and spring semester. Freshman and sophomores made up the majority users in the TSR. In addition, core courses from the freshmen and sophomore years were requested

more than courses from the junior or senior year. Women continued to utilize the TSR at a higher rate than did their male counterparts.

Second Summer Program
The Second Summer Program (SSP) entered its 30th year and has complemented MIT's academic experience in an array of disciplines. SSP is an academic enrichment program that supports underrepresented minority students' intellectual growth while assisting them to develop a keen sense of their professional possibilities as engineers and scientists through an array of internships at various companies. Forty one underrepresented minority students qualified to participate in the SSP by attending three orientation sessions, several workshops on resume writing, interviewing techniques, and passing the core curriculum for the freshmen year. In addition, students were required to participate in the Engineering Design Workshop held during Independent Activities Period. Ethnic backgrounds of this year's students included 20 African Americans, 18 Latinos, 2 Native Americans and one other. There were 14 women and 27 men. Fourteen companies participated in the SSP for the 2000–2001 academic year.

Industrial Advisory Council for Minority Education
The Industrial Advisory Council for Minority Education (IACME) helps ensure greater retention and higher academic achievement of MIT's underrepresented minority students through active support of, and participation in, the realization of the OME mission and goals. Two meetings were held during the 2000–2001 academic year which encompassed two town meetings with the Leadership of the Institute. The first town meeting included Professor Thomas Magnanti, Dean of the School of Engineering and Professor Lawrence Bacow, Chancellor. THE Second Town Meeting participants were Professor Robert Armstrong, Department Head of Chemical Engineering, Professor John Guttag, Department Head for Electrical Engineering and Computer Science, and Professor Nam Suh, Department Head for Mechanical Engineering. These departments enroll the largest number of underrepresented minority students at the Institute. The outcome of the town meetings was that each department pledged to work with the OME to address some of the issues effecting minority students in departments. During the 2001–2002 academic year, the OME will invite each department to meet the staff of the office and identify areas for collaboration. IACME provided both financial and in-kind support to American Indian Science and Engineering Society (AISES), Mexican American Engineering Society (MAES), National Society of Black Engineers (NSBE), and Society of Hispanic Professional Engineers (SHPE). Through the stewardship of IACME, the OME contributed over $20,000 to support an array of professional and cultural organizations.

Office of Minority Education Student Advisory Council
Office of Minority Education Student Advisory Council (OMESAC) provides a mechanism for minority students to bring their concerns and issues to the Associate Dean for Undergraduate Education/Director of the OME. OMESAC's membership consist of cross-section of underrepresented students organizations totaling 18 groups. The council held two Robert Taylor Lecture series during the academic year. In the fall and spring semesters, two events were sponsored to focus on issues affecting minority males and females on the MIT campus. A core of representatives from OMESAC served on two search committees to identify two assistant deans for the OME.

Annual Minority Awards Banquet
This year, Dr. Calvin McKie, Assistant Professor of Mechanical Engineering at Tulane University was the keynote speaker at the Annual Minority Awards Banquet, supported by the Office of Minority Education, the Graduate Students Office, the Office of the President and Counseling and Support Services. Over two hundred and fifty students, administrators, faculty and support staff attended the banquet. Academic and Cultural Awards were presented to students who have contributed to the quality of life for minority students at MIT.

PERSONNEL
Two search committees were convened during the 2000–2001 academic year to replace Ann Davis Shaw and to identify a new professional staff member to address especially the need to support Latino students at the Institute.

Professor William Watson served as the chair of the search committee for the Assistant Dean/Assistant Director of OME. He was joined by Arnold Henderson, Associate Dean /Section Head CSS; Maggie Devine, Staff Support to the CAP; Gail-Lenora Staton, Financial Officer of the OME; David Lowry, AISES; Luwam Semere, Past President of NSBE; Manuel Sanchez, President of MAES; and Candice Albritton, TSR Manager. A national search plan, implemented to reach a wide range of candidates, resulted in one hundred candidates submitting their resumes for the position. An offer has been made and we expect that the candidate will accept.

The second search committee for the Assistant Dean for Advising and Programs was chaired by Professor Daniel Hastings, from the department of Aeronautics and Astronautics Course 16. He was joined by Professor Vernon Ingram, Maria Otera '02, Desiree Ramirez '02, Mishone Donelson '01, Daniel Sandoval '01 and the Associate Dean/Director of the OME. In response to a national search plan, seventy-one candidates submitted their resumes for consideration for the position. The applicant pool consisted of thirty-three men and thirty-eight women. Four candidates were identified to invite to the campus to be interviewed by the committee and other members of the MIT community. The committee was unable to recommend a candidate for the position, even though two of the finalists were Latinos. Plans are being developed to implement another search to identify a Latino administrator.

Leo Osgood

OFFICE OF THE REGISTRAR

The Office of the Registrar promotes the educational goals of the Massachusetts Institute of Technology by conveying to the MIT community and beyond accurate, timely information and providing services related to enrollment, registration, and graduation; by implementing and enforcing academic and administrative policies related to the above; by creating, updating, preserving, and issuing academic records for past and current students and alumni/ae; by developing and communicating official subject, schedule, and curricular program information; by managing and maintaining classroom space; and by publishing in these areas.

In fulfilling its mission, the Office of the Registrar works with the Faculty, Institute/Faculty committees, departments, staff, and students to guide and assist in developing and modifying educational policies and procedures in accordance with Institute policy and local, state, and federal laws. The office will continue to gather, maintain, interpret, and share information—through new technologies, broadened capacities, and enhanced communications—in the areas that the Institute has entrusted to its charge.

ACCOMPLISHMENTS

Much effort was spent this year in increasing our delivery of information and services, analyzing and implementing new faculty policies, and supporting new educational initiatives and community events. The year was also marked by the reorganization of the office as an entity separate from the Office of Academic Services.

The office, in partnership with SSIT:

- Piloted an online departmental picture list which allows departmental administrators access to pictures of all their majors; and
- Analyzed, designed, and developed solutions to the new Communications Requirement. These included a way to audit both GIR and departmental aspects of the requirement as well as an advisory messaging mechanism to support enforcement.

Policy work highlights include:

- Worked with CUP, Academic Services, and Admissions to plan the implementation of the new faculty policy on freshman grading.
- Provided information pertaining to the review of the three-year experimental undergraduate cross-registration program with the Massachusetts College of Art and the School of the Museum of Fine Arts.
- Collaborated with the Chair of the Faculty, Academic Services and the President's Office in educating faculty and departments in the interpretation of the new term regulations for undergraduate subjects, particularly in regards to final exam scheduling and ex-camera finals.
- Developed, in conjunction with the Physics Department, a process for including incoming freshman in the 8.01X lottery for the first time.
- Implemented, in collaboration with the Chair of the Faculty and the Chair of CAP, the office implemented a new version of the Incomplete Instructor's form which includes a default final grade.
- Worked with the Cambridge-MIT Initiative to develop procedures for students wishing to study away in the first year of the student exchange to England.
- The Working Group on Student Information Policy gave several presentations regarding the new Student Information Policy to groups on campus as part of the education plan.

In the area of classroom management the office:

- Led the design effort for Rooms 3-370 and 3-270 and the TEAL classroom (Technology Enhanced Active Learning);
- Led the effort to complete renovations of three medium size classrooms in Building 1;
- Completed partial renovations of four classrooms in Building 33, including new lighting, furniture, audiovisual equipment and improvements to HVAC systems;
- Led the effort to define appropriate technology upgrades in Room 1-390 to support distance education
- Led the effort to upgrade audiovisual systems in Room 10-250. Introduced touch screen technology, flexible laptop connections and new video projection systems;
- Provided technology upgrades to Rooms 4-364, 14E-310, and 35-225 in response to faculty driven needs
- Served on the Stata Center classroom design team;
- Provided new furniture in the Walker exam site; and
- Provided data for numerous classroom studies across campus including the new neuroscience building study.

Operational highlights include:

- Assumed responsibility for maintaining and updating the academic portion of WebSIS
- Enhanced the printed Registration Instructions/Class Schedules book and publication of information on the web
- Enhanced the fall freshman registration form

REGISTRATION

In 2000–2001 student enrollment was 10,090, compared with 9,972 in 1999–2000. There were 4,258 undergraduates (4,300 the previous year) and 5,832 graduate students (5,672 the previous year). The international student population

was 2,489, representing eight percent of the undergraduate and 36 percent of the graduate populations. These students were citizens of 109 countries. (Students with permanent residence status are included with U.S. citizens.)

In 2000–2001, there were 3,335 women students (1,755 undergraduate and 1,580 graduate) at the Institute, compared with 3,287 (1,768 undergraduate and 1,519 graduate) in 1999–2000. In September 2000, 429 first-year women entered MIT, representing 42 percent of the freshman class of 1,017 students.

In 2000–2001, there were, as self-reported by students, 2,780 minority students (1,984 undergraduate and 796 graduate) at the Institute, compared with 2,669 (1,996 undergraduate and 673 graduate) in 1999–2000. Minority students included 402 African Americans (non-Hispanic), 89 Native Americans, 594 Hispanic Americans, and 1,695 Asian Americans. The first-year class entering in September 2000 included 495 minority students, representing 49 percent of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 2000–2001 included 1,183 bachelor's degrees, 1,553 master's degrees, 10 engineer's degrees, and 492 doctoral degrees—a total of 3,238 (compared with 3,199 in 1999–2000).

SPACE MOVES

The consolidation of Registrar's Office operations in Building 5 has provided a wonderful improvement to the work environment. We are extremely grateful for the support from the senior administration in this move. Unfortunately, the move of SSIT to W92 has challenged our ability to work closely with this crucial group.

PERSONNEL CHANGES

Shirley Thompson and Peter Hayes were promoted to administrative staff increasing the number of minority administrative staff members to two. Nancy Swallow was promoted to Assistant Registrar.

New support staff in the office include Jeff DiNicola, Margaret Newell, Rachel Grubb, and Nate Hagee. A few members of the office departed for new positions. Phoebe Minias left the office after 10 wonderful years of service to join SSIT; Denise Vallay left to join RLSLP; and Ertha Baptiste-Ikini left to return to school.

More information on the Registrar's Office can be found on the office web site at http://web.mit.edu/registrar/.

Mary Callahan

ROTC PROGRAMS

AIR FORCE RESERVE OFFICERS' TRAINING CORPS

Mission

The mission of Air Force Reserve Officers's Training Corps (AFROTC) is to train leaders to be commissioned Second Lieutenants in the United States Air Force.

Table 4. Year-End Enrollment In AFROTC As Of June 2001

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	6	13	6	3	28
Harvard	2	0	4	4	10
Tufts	0	0	1	0	1
Wellesley	2	0	0	0	2
Total	10	13	11	7	41

The academic year 2000–2001 at Detachment 365 at MIT was exceptional. Accomplishments include the following.

- The academic year started with a memorable New Student Orientation weekend in September 2000.
- We have eight cadets flying on weekends at Hanscom Air Force Base.
- In October 2000, 20 cadets traveled to Washington DC and visited the Capitol and the Pentagon.
- In November 2000, we had a dining-in with former MIT Graduate LTC Daenick as the guest speaker.
- In November 2000, the detachment sponsored a Veterans Week Program. The week began with a tri-service POW/MIA Vigil at MIT. We also marched in the Boston Veteran's Day Parade.
- In March 2001, the detachment visited the McGuire AFB for leadership training and a KC-10 ride.
- In June 2001, we commissioned 4 MIT graduates and 4 Harvard Graduates as Second Lieutenants

There were two new initiatives this year:

- Colonel Kuconis taught a freshman seminar SEM130 and was a freshman advisor.
- Detachment 365 along with Army and Navy ROTC developed a joint leadership seminar with the Sloan School of Management. This 3-credit seminar was taught during IAP.

Captain Brown left the Air Force and MIT. Major Daniels replaced him in February.

For more information about our program, please visit our detachment web page at http://web.mit.edu/afrotc/www/.

Col. John E. Kuconis

ARMY RESERVE OFFICERS' TRAINING CORPS

The mission of the Army Reserve Officers' Training Corps (ROTC) is to commission officers in the Active Army, Army Reserves, or Army National Guard by providing instruction and training in military science subjects, to include a focus on leadership development.

Accomplishments include the following:

- Department crafted vision and implementation plans to double enrollment by 2005 addressing directly the 10 year negative enrollment trend.
- Commanding General visited MIT and granted $.5M additional scholarship funding for incoming freshman (Class of 2005) totaling $1.5M.
- MIT granted $9K for cadre/faculty tuition; five of ten faculty members enrolled in professional development opportunities.
- The department was presented the best Army ROTC Unit in the Nation Award by the Order of the Founders and Patriots of America.
- The department received the Commanding General's Award for Training Excellence, awarded to the top 5 percent of the 270 programs across the nation, for the second year in a row.
- Major Curran and Sergeant First Class Anderson presented a module on Leadership in Action in the leadership seminar with Sloan's Leaders for Manufacturing program during IAP.
- Sergeant First Class Anderson conducted a seminar for the CIS Security Studies Program on the Battle of Mogadishu, Somalia where he earned the Bronze Star for valor.
- Lieutenant Colonel Baker began an engineering and science outreach initiative with member firms in the Boston chapter of the Society of American Military Engineers. Over 30 MIT undergraduate students (Non-ROTC and ROTC) participated during the past year. Several students have secured internships with industry through this collaborative effort.
- Students in 15.305 Leadership and Management received credit from the Sloan School of Management for the second consecutive year.

At the end of the academic year, 38 students were enrolled in our program. Of those 38 students 15 (39 percent were minority including 10 women (26 percent).

Table 5. Year-End Enrollment In AROTC As Of June 2000

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	5	2	4	1	12
Harvard	7	2	2	7	18
Wellesley	2	2	0	1	5
Tufts	0	2	1	0	3
Total	14	8	7	9	38

Of the twelve enrolled MIT students, eight are currently on scholarship. This year the Army ROTC commissioned 7 new second lieutenants, none from MIT.

Off-campus learning opportunities continued to attract cadets who volunteered for training at Fort Benning, GA (Airborne School) and Fort Bragg, NC (Troop Leadership), and an internship at the Pentagon. Participation continued to be strong in the MIT Pershing Rifles Company, a group of both ROTC and non-ROTC students dedicated to the pursuit of excellence in military leadership and tactics.

Four new faculty members have joined the department: Major Curran, Captain Berube, Captain Wiernicki, and Sergeant First Class Beltran. Five faculty members have departed or are in the process of departing: Major Cho, Captain King, Master Sergeant Velez, Sergeant First Class Anderson, and Staff Sergeant Sullivan. Sergeant Hiett has departed for a six-month temporary duty assignment in Europe.

More information about this department can be found online at http://web.mit.edu/armyrotc/.

Lt. Col. Brian L. Baker

NAVAL RESERVE OFFICERS' TRAINING CORPS (NROTC)

The Naval Reserve Officers Training Corps (NROTC) program at MIT provides challenging and comprehensive professional education for students attending MIT, Harvard, and Tufts. The Program encourages academic achievement, while providing practical experience, to endow the Navy and Marine Corps with capable officers. –

During the 2000–2001 Academic Year, 19 men and women were commissioned. Program enrollment just prior to June commencement was:

Table 6. Year-End Enrollment In NROTC as of June 2001

	Freshmen	Sophomores	Juniors	Seniors	Total
MIT	5	12	10	13	40
Harvard	4	7	0	6	17
Tufts	1	2	6	1	10
Total	10	21	16	20	67

The Navy's financial assistance for MIT students totaled $1,138,000 for the year. We are expecting approximately 17 new freshmen to enter the program this year.

MIT midshipmen are involved in numerous activities throughout the year. In the fall, an annual formal ball was held to celebrate the birthdays of both the Navy and Marine Corps. The MIT NROTC Color Guard participated in the Boston Veteran's Day parade as well as several MIT football games. The midshipman battalion was also active in community service, including cleaning up several Cambridge parks, supporting the New England Shelter for Homeless Veterans, and hosting a Military Excellence Competition for area High Schools. The MIT NROTC sailing team hosted the Seventh Annual Beaver Cup Regatta on the Charles River where the team won first place. Midshipmen also participated in military excellence competitions at Villanova, Cornell, and Holy Cross. The Midshipman Battalion ended the year by hosting the Tri-Service ROTC Pass-in-Review on Berry Field.

During the summer, all scholarship midshipmen participate in active duty training with deployed naval units. This summer, midshipmen served aboard submarines, maritime patrol aircraft, aircraft carriers, and amphibious assault ships, to name a few. This training provides invaluable experience for their future careers as naval officers.

The MIT NROTC unit hosted Rear Admiral Barry Costello, Deputy Director, Plans and Policy, Joint Staff. Admiral Costello spoke about the future of Naval Surface Warfare and discussed principles of leadership with the midshipmen. The unit also hosted Commander Leonard Goff, Commanding Officer of the fast attack submarine, USS City of Corpus Christi. Commander Goff spoke to the unit about the future of the submarine force and what it is like to be a submarine officer.

The culmination of four years of training was reached on June 8, 2001, as twelve MIT students were commissioned as Ensigns in the United States Navy in a service alongside the USS Constitution. The guest speaker was Rear Admiral Michael C. Tracy, Commander, Navy Region Northeast/Submarine Group TWO.

More information about the Navy ROTC can be found online at http://navyrotc.mit.edu/.

Capt. Conrad J. Donahue

STUDENT FINANCIAL SERVICES

The mission of Student Financial Services is to enable students to meet their financial obligations while ensuring access for all qualified students without regard to their financial need. The five core business functions of Student Financial Services are: Bursar, Financial Aid, Loan Services, Student Services Center, and Student Employment.

BURSAR

Student Financial Services has responsibility for the Institute's bursar functions of billing and collecting tuition, Institute-related charges, and related fees assessed to students. In FY2001 the Bursar serviced approximately 17,000 student accounts; conducted 319,911 student account transactions; recorded student tuition of $274,701,654; and received income from Bursary Payment Plan finance charges of $203,000 and from late payment fees of $313,860. Student Account Counselors and the Associate Director, Service Delivery, coordinated activities with Financial Aid Counselors and representatives from the Cambridge-MIT Initiative (CMI) to successfully matriculate the first MIT students to participate in the program between Cambridge University and MIT. The Bursar, with approval from MIT Medical, changed descriptions of medical charges from specific to general to ensure students' privacy.

More information about Bursar functions may be found online at http://web.mit.edu.bursar/.

FINANCIAL AID

Student Financial Services has responsibility for: development of financial aid policy; dissemination of financial aid information; counseling students and parents on financing a MIT education, applying for financial aid, and debt management; determining financial need; packaging financial aid awards; disbursing grants; administering federal, state, and private financial aid; and stewarding financial aid funds, including reporting to donors.

In FY2001 2,304 undergraduates received a total of $54,077,871 in student financial aid, exclusive of student employment. This represents an increase of 7.6 percent from FY2000.

Undergraduate students were awarded scholarships and grants of $42,515,352, an increase of 12.4 percent from FY2000.

MIT Endowed Scholarships	$27,452,394
MIT Unrestricted Funds	$5,782,633
MIT Current Gifts	$1,181,044
Federal Supplemental Educational Opportunity Grants	$1,880,000
Federal Pell Grants	$1,157,063
Federal ROTC Scholarships	$1,015,950
Outside Scholarships	$4,046,268

Undergraduate students borrowed $11,562,519, a decrease of 7.2 percent from FY2000.

Federal Direct Stafford/Ford Subsidized Loans	$5,193,058
Federal Direct Stafford/Ford Unsubsidized Loans	$785,040
Federal Perkins Loans	$3,308,610
MIT Technology Loans	$1,775,369
MIT Parsons Loans	$500,442

Graduate students borrowed $15,033,908, an increase of 5.2 percent from FY2000.

Federal Direct Stafford/Ford Subsidized Loans	$3,411,632
Federal Direct Stafford/Ford Unsubsidized Loans	$4,354,618
Federal Perkins Loans	$1,665,655
MIT Technology Loans	$5,602,003

Total student borrowing by undergraduates and graduates was $26,596,427, a decrease of 0.6 percent from FY2000.
Parents borrowed $8,783,827, a decrease of 7.46 percent from FY2000.

Federal PLUS Loans	$3,001,825
MIT Parent Loan Plan	$2,279,892
Massachusetts Educational Finance Authority	$3,502,110

Total borrowing by undergraduates, graduates and parents was $35,380,254, a decrease of 2.3 percent from FY2000.

More information about Financial Aid may be found on the web site at http://web.mit.edu.finaid/.

LOAN SERVICES

Student Financial Services disburses, bills and collects student and parent loans as well as conducts entrance and exit loan counseling for students to inform them of their rights and responsibilities as well as provide them debt management strategies. Students borrow from four sources: the William D. Ford Federal Direct Loan Program, the Federal Perkins Program, MIT's Technology Loan Program, and the MIT Parsons Loan Program. Parents borrow from three programs: the Federal PLUS Loan Program, the MIT Parent Loan Plan, and the Massachusetts Educational Finance Authority. Student Financial Services is responsible for disbursing student and parent loans from all sources, and for collecting loans from the Federal Perkins Loan Program, MIT Technology Loan Program, MIT Parsons Loan Program, and MIT Parent Loan Plan. In addition to these functions, Student Financial Services collaborates with the MIT Benefits Office to administer the MIT Educational Loan Plan for eligible employees. Beyond the financial aid statistics reported above, during 2001, Loan Services:

- Managed student loan receivable portfolio of approximately $75,953,239 at year-end comprised of $22,480,654 in funds from MIT Loan Programs established by friends and alumni of the Institute, $30,886,678 in funds from the Federal Perkins Loan Program, and $22,585,907 in funds from Mass Bank.
- Conducted 884 exit counseling sessions for graduating students comprised of 604 in group sessions and 280 individual sessions.
- Implemented new federal provisions for rehabilitation of defaulted Perkins Loans effective for FY01. This provision allows borrowers, after making 12 consecutive on time monthly payments, to regain eligibility for federal financial aid and to have all default information removed from their credit history.
- Completed sixth year of participation, FY2001, in the William D. Ford Federal Direct Loan Program.
- Reconciled and completed closeout analysis for fourth year of participation, FY1999, in the William D. Ford Federal Direct Loan Program for disbursements totaling $17,419,376 for the year.
- Collected $4,128,758 in MIT's Federal Perkins Loan Program. The cohort default rate for Federal Perkins is estimated at 5.12 percent for FY2000. This increase is a result of staff turnover and the economic situation in the job market.
- Collected $1,833,433 under the MIT Parent Loan Plan, resulting in a year-end receivable balance of $3,747,741.
- Disbursed $1,905,964 to MIT faculty and staff under the MIT Educational Loan Plan and collected $1,770,698, resulting in a year-end receivable balance of $2,673,707.

More information about Loan Services may be found online at http://web.mit.edu/bursar/alumni.html/.

STUDENT SERVICES CENTER

Through the Student Services Center, Student Financial Services provides a broad range of academic, financial and general customer services to student, parents, alumni, members of the MIT community and others. Academic services include: obtaining an academic transcript, checking grades, acquiring cross-registration information and materials, and receiving certification of enrollment. Financial services include: making payments on a student account, requesting a refund or cash advance, obtaining a financial aid transcript, discussing a student account statement with a student account counselor, signing loan promissory notes, discussing financial aid needs or awards with a financial aid counselor, receiving loan counseling, signing a loan check, obtaining a copy of the financial aid statement, changing a Meal Plan amount and requesting a new student ID card. In addition, students obtain various paper forms, check Student Employment Office job listings and complete various student employment payroll and federally required forms.

The staff of the center strives to work collaboratively with other MIT offices to create a focal point for student contact and make administrative tasks less time-consuming for students, enabling them to focus on their studies and research.

Student Services Center highlights for FY2001 are as follows.

- The service desk staff (Mary Kathryn Mora, Kimberly Huse and Anne McCall) received Infinite Mile Award for outstanding customer service through the Rewards and Recognitions program.
- The official Student Services Center handbook was revised to update policies and procedures consistent with Institute and Student Financial Services demands.
- The office assumed many of the duties performed by the Meal Plan and Card Office representative who previously resided in the Student Services Center. During FY2001, the Meal Plan and Card Office satellite station was discontinued. In order to accommodate students who wished to adjust their Meal Plan balance or replace a lost card, the Center's service desk staff coordinated work with the two home offices. Their efforts curtailed students' trips to E32 to conduct business.
- The staff received on-going team training from the MIT Training Center and through presentations by representatives from other offices. Most recently Constance Scribner from the Registrar's Office spoke with them about registration initiatives.
- Student Services Center was represented at Project Interphase orientation.

More information about the Student Services Center may be found on the web site http://web.mit.edu/ssc/.

STUDENT EMPLOYMENT

Student Financial Services creates and administers student employment opportunities for undergraduate and graduate students enrolled at the Institute, not just financial aid recipients. It also serves as the human resources office for students and their employers, on- and off-campus. MIT academic and administrative offices rely on Student Financial Services to assist them with personnel policies and procedures related to student employees.

The FY2001 student employment highlights are as follows.

- Employment opportunities for MIT students increased to over 1,700 job listings, including many positions at significantly higher pay rates than in prior years.
- The minimum rate on campus was $7.25. The average hourly rate for freshmen was $7.50 and for upperclass the average was $8.50.
- The fourth year of participation in the Federal Work Study Community Service Program ended with an increase in the number of employers as well as employment positions.
- The Cambridge Port Elementary School became a new site, during the fourth year of participation in the federal America Reads Program—Reach Out-Help Teach A Child to Read. There are now four non-profits involved in the program. 85 MIT students work under the federal work-study program or volunteered to help more than 100 Boston and Cambridge youngsters in grades K–5 learn to read at grade level.
- Created a new and exciting America Counts site. The MATCH School's mission is to prepare disadvantaged urban Boston students to attend and excel in college and beyond—including and especially those students who have not been led to expect a university education. This was a perfect match—7 MIT students tutoring and honing math skills for 9th grade kids. The impact was immediate!
- The office validated the identification of 1642 students who completed the federal I-9 form, were approved and processed.
- 6,270 Personnel Action forms, the vehicle by which students get set up on the student hourly payroll.
- A brochure called "Work—The Profitable Student Activity," was developed to provide freshmen and their families an overview of on-campus employment and to show them that a part time job can be a good balance to academic life.
- Two of our student staff graduated—Liz Sharp and Amy Thayer!

More information about Student Employment may be found on the web site http://web.mit.edu/seo/.

Elizabeth M. Hicks

STUDENT SERVICES INFORMATION TECHNOLOGY

The mission of Student Services Information Technology is to provide high quality information services support to a wide-ranging set of users within the Dean for Undergraduate Education, the Dean for Student Life and MIT. This support focuses on the automation of business processes and information systems to provide students, faculty and administrators with timely and accurate information and support.

ACCOMPLISHMENTS

Client – Focused accomplishments uncluded the following:

- Participated in a Discovery effort to determine the best ways to use technology to enhance the advising process at MIT.
- Created PDF formatted picture class lists on WebSIS so they are accessible on all PC platforms.
- Deployed approximately 165 computers across DUE/DSL offices as part of a desktop computer upgrade program.
- Coordinated IT-related aspects of a number of DUE/DSL moves including DUE/DSL Administration, Registrar's Office, Academic Services, Teaching and Learning Lab, Office of Discipline and Conflict Resolution, Student Financial Services, and SSIT.
- Developed web-based process to collect and process freshman seminars catalog information.
- Developed web-based tool to maintain an on-line glossary of MIT terminology.
- Provided web-based graduate housing application entry by students and a lottery process (integrated with Graduate Admissions) to eliminate duplicate data entry, improve communications between housing and academic departments, and provide data for statistical analysis of housing lottery results on yields.
- Implemented a 1.5 percent loan rebate policy per requirements of the Department of Education. This policy was created as an incentive for students to pay their loans in a timely manner.
- For Aid Year 1999–2000, the Department of Education (DOE) approved the Master Promissory Note Project (MPN) as the only approved note for Direct Subsidized and Unsubsidized loans for student borrowers at a specific school. For Aid Year 2000–2001 Multi-Year Master Promissory Notes (MYN) were approved by the DOE. This new change allowed the MPN to be used for many subsidized or unsubsidized loans, for the same student, for multiple years, at multiple schools participating in the MYN functionality.
- In partnership with the Housing Office, created a website to assist an MIT student's search for off-campus housing.
- Created departmental picture lists on WebSIS for Department Administrators to view students by their department or by Course.
- Deployed Who's Teaching What (WTW), a web-based tool to collect detailed data on what teaching roles faculty and TAs have in the classes they teach, to all academic departments.

SSIT – Focused accomplishments included the following:

- Move to W92 – In order to accommodate conflicting space needs, SSIT moved away from the central campus.
- SIS Systems Documentation – Developed a Web-based tool to maintain on-line documentation for Student Information Systems (including User procedures.)
- SSIT Problem Report/Tracking – In collaboration with MIT Information Systems and SSIT Team Leaders, partially implemented the MIT IS developed CaseTracker system.
- Student Life – Focused Analysis/Programming Team – In order to provide focused support for Student Life systems as well as Graduate Admissions, a new SSIT Team was formed with Ayca Darcan as Team Lead.

STAFFING CHANGES

In FY2001 we initiated the implementation of our Consultant Migration Plan (migrating away from utilizing contract analyst/programmers for ongoing work.) In part as a result of the Consultant Migration Plan, four analyst/programmers (Leonard Lu, Mark Briebart, Boguslaw Pierscionek and Shannon Moon) with a variety of skills and experience and a Documentation Lead (Phoebe Minias) joined SSIT.

The Graduate Admissions application support position was transferred from the Office of Admissions to SSIT to provide more technical synergy (both applications and analyst/programmers.)

Robert Rippcondi

TEACHING AND LEARNING LABORATORY

The Teaching and Learning Laboratory's (TLL) most important activities this year revolved around assessment and evaluation. TLL is in the process of creating a range of tools and services that will give the Institute the ability to assess educational efforts in a rigorously analytical way. This work will also serve as the foundation of a research program we are developing primarily, but not exclusively, on the impact of educational technology on higher education. Additions to and promotions within TLL staff have been instrumental in allowing TLL to move in this direction.

TLL was founded in 1997 as a resource for faculty, administrators, and students who share a desire to improve teaching and learning at MIT. Its goals are to: strengthen the quality of instruction at the Institute; further an

understanding of the learning process, particularly in science and engineering; and provide support for the creation and assessment of innovative educational technologies, curricula, and instructional methods.

ACCOMPLISHMENTS

As described above, TLL has three broad, though interrelated, functions: instructional support, assessment and evaluation, and research. TLL's accomplishments in each of these three areas are detailed below. In addition, as TLL has increased its staff threefold this year, we have spent time building the office into a larger, cohesive operation. Activities that contributed to that work are also listed below.

Assessment And Evaluation

We have worked this year to build a solid foundation for TLL's capabilities in this area. Dr. Newman met with PIs and their staffs from each of the iCampus/ d'Arbeloff projects to determine their assessment needs. From these meetings came a report entitled "Assessment Needs at MIT." TLL staff organized and facilitated a series of meetings with experts in assessment on campus and representatives from Microsoft in order to identify important research questions concerning the impact of educational technology on higher education. Three broad streams of research were identified: conceptual learning; student engagement and interaction; and faculty engagement with a particular focus on resource issues. Dr. Breslow and Dr. Newman produced a strategic plan for assessment at MIT. It recommends a two-prong approach: targeting particular iCampus/d'Arbeloff projects for in-depth evaluation and assessment by both on-campus experts and outside consultants; and developing a "coaching" service that will provide assistance to faculty, administration, and students who undertake their own assessment projects. Dr. Newman organized and facilitated two workshops on assessment for PIs and their staffs working on iCampus/d'Arbeloff projects. Several assessment projects of educational initiatives are currently underway or completed:

- An assessment of the iCampus project "Beyond the Firehose: Learning by Doing" (Professor Tomas Lozano-Perez, PI) by Dr. Newman
- An evaluation of the PIVoT project by Dr. Lipson. A preliminary assessment of Mission 2004 by Dr. Lipson Qualitative case studies involving focus groups and interviews for the three freshmen alternative programs (ESP, Concourse, and ISP) by Dr. Lipson
- An assessment of the Resident Associate Advisor Program to be undertaken by Dr. Michael Ryan of the University of Texas-San Antonio.

Dr. Lipson administered and/or analyzed a number of surveys in her capacity as Associate Director of Educational Studies. These included: the College Student Experience Questionnaire (CSEQ), the 2001 and 2000 Engineering Senior Surveys, the COFHE alumni survey, the Core Institute Alcohol and Drug Survey. Survey assistance was also provided to the Office of Career Services, Course 13, and Project Interphase. Dr. Lipson is a member of the ABET working group and Academic Services Representative to CUAFA.

Research

As explained above, our intention is to use the data we derive from assessment and evaluation, as well as other research TLL staff members undertake, to contribute to the literature on higher education. To that end, during this summer, we are working with four UROP students who are doing literature searches in the areas we have targeted for study. In addition, Dr. Breslow, working with Dr. Donna Qualters of Northeastern's Center for Effective University Teaching, is continuing a research project on interdisciplinarity that will use the HST program as a case study. Observations and interviews will begin this fall.

Instructional Support

TLL has continued to offer the services and programs in instructional support that it has developed over the last several years. These include: the Class Videotaping and Consulting Program, departmental workshops, consultations with individual faculty and departmental committees, microteaching workshops, orientations, the IAP series "Better Teaching @ MIT," and Dr. Breslow's "Teach Talk" column in the faculty newsletter. New activities this year include:

- The organization and facilitation of the "Educational Change Seminars," monthly seminars on educational issues offered to the iCampus and d'Arbeloff PIs and their staffs.
- The organization of "TLL Associates," a group of educational experts on campus who will advise TLL on its activities, as well as work with TLL staff on specific projects.
- The development of projects in cooperation with Academic Computing, including: a series of "best practices" papers on the use of various educational technologies; a joint workshop (or workshops) to be given during IAP; input on assessment tools to be developed as part of Stellar.

Other Activities

Other notable TLL activities included the following:

- Dr. Breslow was invited to be a member of the International Advisory Committee for the second symposium on Teaching and Learning in Higher Education sponsored by the National University of Singapore.
- Dr. Breslow co-facilitated a two-day faculty development workshop sponsored by the Chinese Ministry of Higher Education at Lignon University, Ghangzhou, China.

- Dr. Newman is on the leadership committee of Project Kaleidoscope's Faculty of the 21st Century, and is helping to write the NSF 10-year report on that program's contribution to the reform of SME&T undergraduate education.
- Dr. Newman is providing assessment consultation to the Council on Undergraduate Education's project to assess national outcomes of student research activity.
- Ms. Swire created a new TLL web site that reflects our expanded activities.

STAFFING CHANGES

Dr. John Newman joined TLL as Associate Director of Assessment and Evaluation in December 2000. Dr. Newman had previously been Coordinator of Research and Evaluation at the Searle Center for Teaching Excellence, Northwestern University. Dr. Alberta Lipson and Ms. Rosanne Swire, who had previously been part of the Office of Academic Services, joined TLL as Associate Director for Educational Studies and Research Assistant, respectively. Ms. Cynthia Dernay Tervalon was promoted to Staff Associate in May 2000. Ms. Brenda Blais joined TLL in June 2000 as Administrative Assistant. Ms. Blais, who has 13 years experience at MIT, was most recently with the Department of Urban Studies and Planning.

Lori Breslow

DEAN FOR STUDENT LIFE

This was a very exciting year in that it was the first year in which the new Division for Student Life existed. The new Dean, Dr. Larry G. Benedict, arrived on campus in mid-August, joining MIT from Johns Hopkins University. Much of this first year was devoted to the "basics," focusing on a number of infrastructure issues.

BUDGET
A new divisional budget formulation process was created, including an approach to setting divisional priorities in the budget request process. A balanced budget was proposed, and the fiscal year ended without any divisional deficit. A full time budget officer, Deb Fairchild, was transferred to the division.

HUMAN RESOURCES
All job descriptions were reviewed and updated. An annual performance appraisal process was adopted for all staff. A staff development committee was formed and a number of staff development workshops were conducted including Planning and Evaluation, Basics of Budgeting and Affirmative Action Principals and Practices. A full time organizational development person, Laura Capone, Director of Organizational Performance, was hired.

POLICIES AND PROCEDURES
A Parental Notification policy was developed and disseminated. The Confidentiality Policy was clarified jointly with MIT Medical and Campus Police. A policy to treat cases of alcohol abuse as a medical issue and not just a disciplinary issue is being developed with MIT Medical and Campus Police.

FACILITIES
Groundbreaking occurred for a new graduate residence hall at 224 Albany Street. Groundbreaking occurred for the New Zesiger Sports and Fitness Center. Planning was completed and work begun on a new graduate residence hall at Sidney-Pacific.

TOWN-GOWN RELATIONS
A proactive policy was developed with respect to interactions with the Cambridge License Commission which has allowed MIT to manage more effectively internal issues around the FSILGs.

DISCIPLINE/CONFLICT RESOLUTION
The Office of Student Conflict Resolution and Discipline, and the area of Student Conflict Resolution Mediation and Discipline within RLSLP were merged, into one coherent whole, under the leadership of Dean Robert Randolph with the goal of establishing a more coordinated campus approach to discipline.

INITIATIVES WITH UNDERGRADUATES
The Transitions Lounge in the Student Center was opened after the space sat empty for two years. The Coffeehouse in the Student Center was totally renovated. "Courses," a new eating establishment, was opened on the first floor of the Student Center. A series of Stochastic Dinners was undertaken jointly with the Undergraduate Association to bring faculty, staff and students together in informal conversations. The Undergraduate Association meeting space in Room W20-400 was renovated. An agreement was negotiated with the MIT Technology Licensing Office to direct royalties from the sales of class rings to the sophomore class.

INITIATIVES WITH GRADUATE STUDENTS
Planning for community space in Sidney-Pacific, the new graduate residence hall, was completed with significant input from the GSC. A new finance staff person was added to the GSC office. A new monthly billing process for rents was designed for Ashdown and Green at the request of the GSC. The Student Activities office began support of the financial accounts of all 60 graduate student groups.

The rest of this report details the many other exciting accomplishments of the division's individual units. Suffice it to say that DSL and its staff had a very productive "freshman" year.

THE CHAPLAINCY
Programmatic
This year Chaplains provided integral support to students and families in times of crisis. The return of The Hands sculpture was positive for the community.

Operational
Dean Randolph is focused on developing the plans for an administrative infrastructure that will allow the Chaplaincy to be fully integrated with MIT's administrative processes and systems.

Staffing Changes
Reverend Jane Gould was replaced by the Reverend Amy McCreath. Reverend Constance Parvy retired in June. Reverend Johanna Kiefner will replace her beginning August 1.

DEAN ON CALL

The Dean on Call staff handled 187 matters. Matters handled include: two student deaths on campus; 53 serious matters (severe depression or possible suicide, large party out of control, severe academic problem, assault and sexual assault, student in hospital or jail); 112 other calls from students, housemasters, police, faculty.

Phillip Bernard and Karen Nilsson joined the four-person team from DSL to provide coverage at night and on weekends.

Larry G. Benedict

ATHLETICS, PHYSICAL EDUCATION, AND RECREATION DEPARTMENT

The mission of the department is to stimulate personal growth and development of a balanced, healthy lifestyle for all members of the MIT community through education, competition and recreation.

ACCOMPLISHMENTS

The Office of the Director completed the department's strategic plan and allowed for a smooth transition between Directors of Athletics. In addition, the IT in Athletics, Physical Education and Recreation (IT/APER) Discovery project is underway. The goal of the IT/APER discovery project is to analyze and redesign business processes and technological systems that support the aforementioned service areas in Athletics.

The Facilities Office completed the following projects: a Card Access System was installated; the Crew boathouse lobby and exercise room floor was replaced; the du Pont locker area was renovated; the Johnson Track renovated; a scoreboard for Women's Softball was Procured; the room and floor of the Sailing Pavilion was renovated; and the Steinbrenner Track renovated (scheduled for completion in July of 2001).

The Operations Office computerized the sales of Athletic Cards; coordinated project management for the Sports and Fitness Center for the Athletic Department; developed list serve for Alumni Pool patrons; hosted over 60 MIT and Community events in Department facilities; and participated on newly formed Safety Committee.

Office of Physical Education

Table 1. Physical Education Classes—Enrollment Data

First Quarter	1639
Second Quarter	917
Third Quarter	1554
Fourth Quarter	1071
IAP	1360
Total	6541 (decrease of 1383 from 1999-2000)

Sales of athletic cards decreased by 452 from 1999-2000, totalling 6,651 primary sales and 453 family sales.

Table 2. Sales of Athletic Cards

	Primary	Family
MIT Staff	637	88
MIT Staff-Half	515	20
MIT Faculty	210	42
MIT Faculty-Half	33	7
Draper	165	11
Draper-Half	35	1
Whitehead	49	7
Whitehead-Half	11	3
Lincoln Lab	13	4
Lincoln Lab-Half	1	0
Summer Staff	7	0
MIT Student	4956*	236
Wellesley Student	8	0
Wellesley Student-Half	4	0
Summer Student	12	0
Alumni	140	23
Alumni-Half	42	3
Sponsored	9	0
Monthly	94	0
Weekly	2	0
Add On	8	8

*Students who chose to activate their athletic cards following the tuition deduction

Club Sports
No figures are provided for club sports.

Intramurals
Table 3. Enrollment data for Intramurals

Badminton	244
Basketball	1250
Billiards	300
Billiards Tournament	50
Bowling	128
Foosball	50
Football	1000
Hockey	1200
Octathon	320
Roller Hockey	144
Soccer	1260
Softball	1200
Squash	120
Table Tennis	300
Team Tennis	531
Tennis Tournament	41
Triathalon - Women	75
Ultimate Frisbee	300
Unihoc	300
Volleyball	1200
Water Polo	300

This data represents 21 Sports/Activities with a total of 10,293 participants. Both activities (by two) and participants (by over 2,400 participants) increased over the previous year's figures.

Varsity Athletics
Seven hundred forty-seven students participated in 41 varsity sports programs. Seven student-athletes were named Verizon Academic All-Americans. Sixteen Student-Athletes were named All-Americans. The Men's Lacrosse, Women's Basketball, and Women's Volleyball Teams qualified for the Eastern College Athletic Conference New England Championship. Men's and Women's Fencing won the combined New England Championship. Men's Gymnastics qualified for the national championships for the first time since 1995. Men's Ice Hockey won the New England College Hockey Association championship for the third consecutive year. Men's Tennis qualified for the NCAA Division III Championships and finished 8th in the country in Division III. Men's Indoor track finished 11th at the NCAA Division III Championships for the best finish for the team since 1989. Men's Water Polo won the Eastern Division III Championship. Four teams qualified for the New England Women's and Men's Athletic Conference Champions: Men's Cross Country, Men's Outdoor Track and Field, Men's Tennis, and Women's Tennis.

STAFFING CHANGES
Candace Royer was promoted from Director of Physical Education to Director of Athletics/ Department Head. Anthony Brock was hired as Men's Freshman Lightweight Crew Coach. Brian Callahan was promoted to Aquatics and Equipment Coordinato. Gordon Hamilton was promoted from part-time position of Men's Varsity Heavyweight Crew Coach to full-time. Will Hart was named Pistol Coach and Range Master. Jean Heiney was reassigned as Interim Director of Physical Education. Roy Horsey was named Rifle Coach. Ian Hutton was promoted from interim to Head Coach of Lightweight crew. Michael Johnson was hired as Nordic Ski Coach, resigned at the conclusion of the season. Mike Kali was named Women's Sailing Coach and Assistant Sailing Master. Mike Lane hired as Men's Freshmen Heavyweight Crew Coach. Susan Lindholm was promoted from interim Women's Varsity Crew Coach to Women's Varsity Crew Coach. Carol Matsuzaki was promoted from part-time Women's Tennis Coach to full-time. Theresa Saucier hired as Athletic Trainer. Jon Shefftz resigned as Alpine Ski Coach.

CAMPUS ACTIVITIES COMPLEX
The Campus Activities Complex (CAC) offers a range of programs, services and facilities meant to support the diverse social, educational, religious, and living needs of the MIT community. Through its efforts in facilities management and event support, campus dining, retail and administrative services, and campus programming, the CAC strives to provide a nurturing and supportive environment for students and the rest of the MIT community to interact, grow, and pursue their individual and group interests. It supports the practice and appreciation of the arts, participation in campus and student activities, and the provision of conveniences that support the quality of campus life.

ACCOMPLISHMENTS

Administrative and Retail

In the summer of 2000 the retail consulting firm of Todreas Hanley performed a review of the Stratton Student Center retail market to assess the market potential and to recommend retail offerings that will be successful on campus. Additionally, a pedestrian traffic study of the Stratton Student Center, performed by the Kopel Research Group, found that approximately 9,000 people access the building daily or the calculated figure (after weighting) of 2,148,143 people annually. These two studies were put into use in a joint development project with the MIT Real Estate Office and the Department of Facilities' Capital Project Development Office to rejuvenate the first floor retail area of the student center with new seating and semi-permanent market stalls. This project will be implemented in the fall and winter of the upcoming year.

A Strategic Planning Process was initiated for Walker Memorial and the Stratton Student Center. An outside consulting firm was hired and a campus client team was established. A series of community interactions and discussions have been conducted, along with a web-based student assessment survey of the Stratton Student Center. A final report is intended for release in the fall.

The occupancy levels of the retail portion of the Stratton Student Center were maintained from the prior year, and a long term lease was signed with Laverde's Market to ensure a high level of quality and uninterrupted service to the MIT campus.

Located in the Student Center, the CAC provided business services for the campus with the oversight of multiple retail tenants: the 24-Hour student-managed Coffeehouse, the Game room, the Source Box Office and the Student Center Lobby Vendor Program.

Facility and Event Operations

CAC operations staff was available 24/7 providing event and facility support. Use of CAC spaces this year numbered 19,840, with 51 percent being used by students, and 49 percent by Institute offices and affiliates. Of the 49 percent used by Institute offices and affiliates, the breakdown was:
44 percent by institute department programs, four percent by Conference Services, and one percent by Government and Community Relations. Increased support went to Freshman and Pre-Frosh activities, Spring Weekend, Family Weekend, Commencement and Alumni activities, and other large institute events such as Odyssey Ball and the Johnson Games. CAC continued its commitment to maintaining a clean environment in its buildings. In a continuing effort to improve common areas and create comfortable areas in which the MIT community can meet, study and hold events, new seating and furniture were added in several locations, including: permanent outdoor patio seating added at Morss Hall and Courses Restaurant and four new barbecue pits added in the area behind Kresge Auditorium. Improvements to the lounge space known as Transitions, located on the first floor of the Student Center, are currently in the works. CAC continues to collaborate with Campus Police, Athletics, Housing, the Registrar's Office, and RLSLP on joint programs and issues through a weekly Event Meeting.

Scheduling and Event Management

The Concerts Office was added to EMS (CAC's event scheduling system) and its personnel were trained in EMS. An EMS consultant visited to recommend improvements to EMS and to provide further training for staff in EMS. The reservation area of CAC processed 25,283 space requests: 11,498 (45 percent) were for student groups. 13,785 (55 percent) were for institute offices and their affiliates. Of the 13,785 (55 percent) requests, 11,748 (46 percent) were for departments, programs, and administrative offices; 1,902 (eight percent) were for Conference Services; and 135 (one percent) were for Government and Community Relations.

Renovations

A $556,000 renovation to the newly renamed Courses Restaurant (formerly Networks Restaurant) resulted in a new operating concept, with focus on variety, display cooking and healthier options, including a wide variety of vegetarian offerings. A $345,000 renovation of the 24-Hour Coffeehouse on the third floor of the Student Center was completed in January. The new layout and décor enhances the facility and has increased the social program offerings. The Room W20-400 meeting space was upgraded with improved lighting, carpeting and seating. This space will now effectively respond to the needs of the undergraduate governance organizations as well as meeting and conference groups.

Dining Services

Dining Services developed a business plan with specific strategies for the revitalization and reorganization of Campus Dining to ensure greater community and a competitive vendor environment. The office developed full costing model for Campus Dining, the first auxiliary department to work with the Budget Office under the Executive Vice President's initiative. Combined with the business plan strategies, this will provide the foundation for a comprehensive dining program, including new operational models, capital needs and financial expectations. Development of MIT's student dining committee continued, including work with Undergraduate Association leadership to ensure effective student influence over food services. The office recruited a new operations manager, creating core personnel infrastructure for Campus Dining and helping to ensure ongoing quality control and support

in implementing new plans and strategies. The operations of the MacGregor Convenience Store were expanded and enhanced with facility improvements and investment in contemporary merchandising equipment.
With the BioSafety Office, a sanitation tracking and action system was established for all operations, enhancing response to repetitive operational health issues. The office coordinated a successful and safe I-Fair with the International Students Association.

Efficience was improved in several areas by establishing the following procedures:
The office implemented a patented key system for all dining facilities, improving security and inventory control. Repair and maintenance procedures were tightened, reducing expenses, downtime and longevity of assets. Procedures were established for the evaluation, storage or liquidation of old equipment.

Additional accomplishments include:
Dining Services maintained active and contributing membership in the EPTF. The office expanded the composting program on campus to include Baker Dining and Next House Dining. The office cleared old store areas and donated furniture and other items to student furniture exchange.

CAC Program Board
The CAC Program Board continued to offer a variety of programs and events including its annual "Take-a-Professor-to-Lunch Week." One hundred, ten students participated in taking a professor to lunch. Ten restaurants participated in the program, including three on-campus and seven in Cambridge and Boston.

The Program Board initiated a new weekly performance series on Thursday nights in the newly renovated Student Coffeehouse. Events ranged from poetry readings to a magic show, with a focus on musical performances that included cappella, jazz, and open-mic nights. More than twenty performances took place over the course of the academic year, with a total attendance of nearly 500. The series relied heavily on students, who not only represented a majority of the entertainers but also helped to organize and promote the performances. The Board sponsored and ran its annual campus recreational tournament. Winning students were sponsored to travel and compete in New England and international tournaments provided through the Association of College Unions International.
The Quiz Bowl/College Bowl program sponsored an MIT team that competed in a number of intercollegiate events, including its own MIT Beaver Bonspiel tournament hosted at MIT. The team also competed in both the National Tournament held in Philadelphia and the International Tournament held in St. Louis. A special grant of $10,000 to support the program was provided by Cisco Systems.

Hobby Shop
The Hobby Shop implemented new web page and completed preliminary plan for Hobby Shop renovation. The shop provided facilities and design consultation for 2.971 (OME) Second Summer Design Class. This year the shop offered the following classes:

- A 2000 Freshman Advisor Seminar 3A.19 "New England Furniture before the Revolution" with Professor John Vander Sande;
- New summer class for 2001 "Intro to Designing and Building Furniture";
- Five programs during IAP including new workshops on table saw use and tool sharpening; and
- The spring undergraduate seminar SP.745 Green Woodworking expanded to 2 sections.

The shop planned new Freshman Advisor Seminar "Product Design" to be taught with Professor Martin Culpepper in fall 2001. Research of Hobby Shop member names from 1939-1965 was completed for a future newsletter. The Hobby Shop also completed bench space renovation and added dust collection for table saw.

Student Art Association
After four years of preparation and fund raising, our Digital Theatre will be opening during fall term. New classes include: Nature Photography; Photographing the Human Form; and Pottery—A Step Up From Beginning (combined hand and wheel). Our enrollment remains the same and is at capacity.

Talbot House
Operations continued at Talbot House, MIT's lodging facility in So. Pomfret, Vt., although discussions are underway to consider the long-term viability of the program. Participation in 2000–2001 was down to 522 visitors of which 304 were students. A substantial review of life safety and maintenance was conducted with staff from the Facilities Department and Safety Office. As a result, $20,000 was provided to upgrade problems considered needing immediate attention.

Special Community Services
The annual Community Giving at MIT Campaign ran from November to February and reached over 100 percent of its $350,000 goal by raising $373,000. Professor John Deutch served his second year as Campaign Chair along with Co-Chair Bill Wohlfarth.

Highlights of the Campaign are as follows: The Campus Book Fair contributed to the Campaign, which assisted both the United Way and the MIT Community Service Fund. A clothing drive was also held during the Campaign to help raise community awareness. Over 1200 members of the MIT community donated to the Campaign, with 95 giving $1,000 or more. MIT was awarded the "Spirit of Sharing Award" by the United Way of Massachusetts Bay

for the third consecutive year. The Quarter Century Club (QCC) Office inducted 84 new members into the Club in March, bringing the membership roster to over 2,900 active and retired employees. Events held during the year included The Summer Picnic (annual), The Silver Club High Tea for Ladies and The Holiday Gathering. This program transferred out of CAC on March 1, 2001.

STAFFING CHANGES

Numerous staffing changes occurred over the past year, including those brought about by reorganization: Ted Johnson, Associate Director of Programs, resigned after 14 years to take a new position with the MIT Office of Conference Services, Events and Information Center. Elizabeth Mulcahy, Administrator for the Special Community Services Office retired after 39 years of service to MIT.

New staff welcomed into the department during the past year were: Dr. Jennifer Smith as Assistant Manager for Event Planning, Ward Ganger as Dining Manager, Patrick McEachon as Operations Supervisor, Andrea Lathrop as Administrative Assistant to the Director, and Lianne Scott as Central Office Administrative Assistant.

The shift of the Office of Special Community Services to the MIT Office of Conference Services, Events and Information Center brought with it the transfer of Annmarie Foley and Diane Tavitian out of CAC. By year's end, Patrick McEachon and Andrea Lathrop had resigned to pursue other career opportunities. Jim Schubert served as CAC's graduate assistant for program

COUNSELING AND SUPPORT SERVICES

The office of Counseling Support Services participates in the following activities: Counsel, advise and advocate for undergraduate and graduate students regarding personal and academic issues. Participate as an active non-voting members of the Committee on Academic Performance. Review and process leave of absence applications, readmissions and voluntary and medical withdrawals. Provide programming for diverse student constituencies. Collaborate with MIT Medical, especially Mental Health, to support students in need. Assist parents, faculty, campus police and administrators with student-related issues.

ACCOMPLISHMENTS

The office completed readmissions process for all returning MIT undergraduates (except those who have been required by the CAP to withdraw on two occasions). Counseling Support Services collaborated with the Committee on Academic Performance to facilitate discussions of students' performances, academic petitions and undergraduate policies. The office continued to work closely with Mental Health and MIT Medical to service a student body with many challenging issues. The office contributed to formation and development of Students At Risk group
The office successfully advocated for students emergency fund to assist growing numbers of students in crisis.
A long search process to identify and hire an Asian-American mental health professional (counseling dean) was successfully completed.

Counseling Support Services collaborated with the Campus Committee on Race Relations, Interphase, and MITES. The office provided in-service Training for CSS Staff (four speakers), Les/bi/gay Programming, Loni Ding's "Who Is An American, and Who Decides?", and Nightline Peer Counseling. The office participated with the Martin Luther King, Jr. Committee. The office also participatied in First Year Student Orientation. Institute-wide collaboration with other services was provided for Sexual Assault Awareness programming. The office visited MacGregor and Random Houses and Zeta Psi ILG. The office held workshops and programs for women and minority students from all backgrounds.

STAFFING CHANGES

After being with CSS for two years, Staff Associate Suzette Clinton was hired for a new position with greater professional responsibility at the Division of Bioengineering and Environmental Health in October 2000. Kunya Des Jardins was hired as an assistant dean in July 2000.

MIT CARD OFFICE

The mission of the MIT Card and the MIT Card Office is to actively contribute to the convenience and quality of life of our students, faculty, and staff. With a focus of customer service, the card should serve as the Institute's universal passport to the widest possible array of campus services, facilities, and activities. It should be aggressively marketed, widely accepted, self-supporting, and offer convenient, round-the-clock customer service.

ACCOMPLISHMENTS

Mission and organization of the MIT Card Office were entirely recrafted in the past year. As one element of that redesign, the MIT Card Office will leave the Office of the Dean for Student Life and will report to the Director of Enterprise Services (Steve Immerman) of the Office of the Executive Vice President, effective July 1, 2001.
The process that was used in establishing a new Card Office mission and organization is described in the section that follows.

A three-person team, led by Interim MIT Card Office Director Kirk Kolenbrander and including Greg Anderson and Matt Brody of MIT Information Systems, studied the existing MIT Card Office and the MIT Card. After researching practices at MIT and at a number of universities across the nation, the team concluded that the students, faculty, staff, and affiliates of MIT and the Institute itself were not well served by the existing products, objectives and organization of the MIT Card Office. The team also observed that the Card Office had become an insulated business unit that offers an array of services that are inadequate, needlessly duplicated in other business units, and poorly customer-based.

In creating a new mission for the MIT Card and its office, the team established the following principles:

- One card will serve as the only card that individuals need to carry for routine personal use, on or off the campus.
- That card will function as the primary platform for the identification, access, individual purchasing, and Institute services needs for all members of the MIT community (students, faculty, staff, and affiliates).
- The office that administers that single card will be a fully self-supporting business enterprise that obtains its revenue stream through card swipe transaction fees, reader connect fees, interest earned on debit card balances, and replacement card fees.
- That office will feature fully centralized control of the card platform, hardware, and software, but will allow highly decentralized control of the specific business applications to the array of business users.
- Card functionality will be built upon a principle of customer service. With a particular focus on the needs of our resident undergraduates, the card will offer superior, responsive service to individual card users and those services that leverage the card. Extended service hours will characterize the effort, with replacement card services at locations across the campus throughout the day and night.
- Through the proactive leadership of the office director, card services will inspire confidence among the users and will forge productive relationships among users and the service providers and vendors. Through the director, the office will implement a rich communications plan to insure service and accuracy of information.

The team prepared a report that proposed a new mission for the office, identified the principles that support it, and made recommendations to achieve it. Those recommendations were supported by observations of other universities' implementations and with descriptions of revenue sources for MIT. The report and its recommendations were adopted first by a meeting of the Dean for Student Life, the Vice President for Information Systems, the Director of Facilities, and the Director of Enterprise Services. That group then forwarded the recommendations to the Executive Vice President and the Chancellor and received their final approval.

In addition to the broad changes within the office, a number of significant enhancements were added to the day-to-day operation of the office. Passport photos may now be conveniently obtained for a small fee at the office, and this service has quickly become popular. To serve the increasingly large group of alumni users, extended hours have been added to provide early morning and evening operations on select weekdays.

STAFFING CHANGES

Lawrence Maguire retired as Director of the MIT Card Office on October 1, 2000. Kirk Kolenbrander served as Interim Director for the period October 1, 2000 to June 30, 2001. For that interim, Dan Michaud and Shueh-Lin Lee (Administrative Staff Assistants) served as Co-leaders of the Customer Satisfaction Team and were responsible for the day-to-day operations within the office. Michael Collins was appointed Administrative Staff Assistant on January 1, 2001.

OFFICE OF STUDENT CONFLICT RESOLUTION AND DISCIPLINE

It is the mission of the Student Conflict Resolution and Discipline System (SCRDS) both to contribute to an environment in which every student can get the most out of his/her academic work and life on campus and to teach students to be good citizens of MIT and the world. To those ends, the system must be easily accessible, clearly defined, well publicized, and fair. It must encourage resolution of issues at the lowest or simplest level and provide a fair central process when needed. The functions of discipline, mediation@mit and student conflict resolution merged together to form one coherent whole, the Office of Student Conflict Resolution and Discipline.

MEDIATION

The demand for training in conflict resolution remains constant. IAP and spring sessions of 36-hour Basic Training in Mediation certified 37 mediators. Conflict Resolution Training, co-led with Ombuds staff, graduated 16 participants. A session on Getting along with your Roommate was held for 20 graduate students living in Edgerton House. Cases mediated include: four inquiries, no mediation, six mediations reaching agreement (seven graduate, four undergraduate and two staff), one facilitation of group discussion co-lead with MIT Medical department.

CONFLICT RESOLUTION AND DISCIPLINE

The number of cases referred by Campus Police declined sharply: zero noise complaints and zero students caught on roofs or prohibited areas (two of the largest categories in the last two years). TheOffice received 15 formal complaints against students from faculty and staff; two heard by a five-member DSL panel, 12 were heard by Administrative Reviews.There is one case pending. A wide range of sanctions were imposed by panels following reviews. Sanctions ranged from not allowing a student to register or receive a degree until certain criterion were

fulfilled, to 25 hours of community service, to no finding on the charge. The office received and processed warning letters against 76 students for academic misconduct. This is over a seven-fold increase from the past year. The office staffs the Committee on Discipline (COD). COD heard charges against nine students, eight for misconduct, one was for personal misconduct. One charge was withdrawn and three remain to be heard during the summer. Sanctions ranged from withholding a degree, expulsion, and suspension to informal probation. COD also reviewed a number of petitions to remove disciplinary notations from transcripts, as well as a petition to be allowed to receive a degree.

PERSONNEL

Dean Randolph was appointed office head for the Office of Student Conflict Resolution and Discipline. Carol Orme-Johnson and Betty Sultan are the Assistant Deans for the Office. Moon Nimon transferred from the Office of the Dean for Student Life to provide administrative support to the Betty Sultan and the discipline system.

RESIDENTIAL LIFE AND STUDENT LIFE PROGRAMS

As Residential Life and Student Life Programs (RLSLP) moves towards the transition in residence selection occurring in the fall of 2002, we have undergone marked organizational and structural growth and development. Changes recognize that the shift in residence selection is creating opportunities for enriching community both in living groups and across campus. This year has poised RLSLP to more effectively and fully realize its multifaceted mission. Embodied by our theme "Thrive: Living at MIT," highlights from our central mission include:

- Facilitating learning beyond the classroom;
- Promoting faculty and student interaction;
- Encouraging student responsibility and support a high standard of conduct;
- Striving to provide a high quality, safe environment;
- Fostering the development of essential life skills; and
- Maintaining flexibility and diversity of services.

ACCOMPLISHMENTS

Daily Operations

Central operations staff worked with all House Managers to develop stronger programs in areas of desk operations, custodial services, and repair and maintenance, in addition to developing stronger participation by each House Manager in their House Team. The program launched a new fire safety program in collaboration with the Dormitory Council and the Safety Office consisting of inspections for all rooms. As members of MIT's Environmental Programs Task Force, RLSLP increased recycling containers and joined with Facilities for a new curbside pick-up. As members of MIT's Emergency Response Group (ERG), staff continued work with the Director of Public Safety to improve MIT's overall emergency response. Two staff joined the Dean on Call Team—Phillip Bernard and Karen Nilsson. Evaluation of facility support of student life in residence halls yielded concerns regarding the quality and equity of some of MIT's older residence halls. As a result, upgrades were undertaken in Bexley Hall, Random Hall, and East Campus, including lounge furniture replacement, paint and carpet renewal, and quality improvement of recreational spaces. Efforts will continue to increase the quality of student life in these halls.

Evening Operations/Nightwatch Program

The overall program underwent comprehensive evaluation for areas of development and improvement. The program enhanced emergency response procedures and communications with the Dean on Call team, including development of accurate list of all house vacancies available for emergency moves. Enhanced training was provided for staff in areas of security and environmental safety. A program was developed and implemented to ensure shift coverage while offering professional development opportunities for union staff.

Construction

RLSLP worked with the Department of Facilities and the Treasurer's Office on construction initiatives for Simmons Hall, Sydney and Pacific, and NW30. NW30 space was designed. Construction began and will be completed by August 2001. Student room assignments are complete, and students will begin to occupy the building on August 16, 2002. Sydney and Pacific building design is ongoing. Groundbreaking has occurred and initial structural work has begun. Determination of programs is ongoing. Major design of Simmons Hall was completed. Foundation has been laid and construction is underway.

Capital Maintenance Projects

The following Capital Maintenance Projects were completed:

- Window Replacement/window security screens: NW61, W1
- Waterproofing/Pointing: E55, W51, W84, W85
- Bathroom Renovations: 62-64, E55, NW61, W1, W4, W5, W13, W51, W61, W70, W71, W85
- Kitchen Renovations 62-64, E55, W1, W4, W5, W13, W51, W61, W70, W71, W85
- Plumbing/Mechanical Renovations: 62-64, E55, NW61, W1, W4, W5, W13, W51, W61, W70, W71, W84, W85
- Electrical Upgrades: 62-64, E55, NW61, W1, W4, W5, W51, W70, W71, W85
- Paint Program: All Dorms
- Fire Alarm Upgrades to state of the art systems: 62-64, NW61
- Front Desk and/or Entrance Renovations: W13, W84

- Housemaster Kitchen Renovations: W4, W5, W71
- Roof Replacement: W85 Lowrise. Marks the completion of program to renew roofs on all residence halls.
- Playground Equipment Renovation, first phase was completed, W85
- Dance Studio Renovation, W4

Graduate Single and Family Housing
1467 out of 5832 graduate students received on-campus housing. The vacancy rate for the Greater Boston area is at an all time low, increasing demand for our limited campus facilities. The demand for family housing (graduate and undergraduate) continues to increase, raising the need for review in the near future. A new "user friendly" web-based housing application form was brought on-line, enabling more convenient service and a more efficient lottery. Computing and use of MITSIS continues to improve service. In collaboration with the Graduate Student Council and Deans for the Graduate School and Student Life, RLSLP developed new housing policies, including clarification of the definition of new (first-year) and continuing students, with the goal of enhancing equity within the graduate housing lottery. The billing processes for Ashdown House and Green Hall were changed; all graduate houses now bill on a monthly basis.

Undergraduate, Summer, and Conference and Guest Housing
For the second year in a row, a second lottery was necessary to place incoming first-year students, after which we were able to place 98.8 percent of first-year students in one of their top three choices. In cooperation with the Dormitory Council, RLSLP developed a web-based lottery program for fall 2001, for temporary assignments in order to study the proposed 2002 housing process, as well as the effects temporary housing assignments have on permanent housing choices and assignments. The office developed and implemented a computer database for all conference and guest housing programs, resulting in more effective allocation of available residential space. For the first time summer assignments were made centrally via the web. This allowed house managers to concentrate on turning the buildings over, rather than on housing requests. This improvement as a result of a study done by Jennifer Frank '00.

To increase customer service and modernize procedures, web-based information and applications were developed. A primary outcome is enabling students and their families to more effectively investigate residential options prior to arrival on campus.

Off Campus Housing Service
The off campus, metro-Boston rental market is still at a crisis level, with a vacancy rate below three percent. On March 1, 2001, an available rental listing web site, https://web.mit.edu/rlslp/och/listings, was launched. In April, there were more than 35,000 hits on the site. It was expected that on-line listings would reduce foot traffic in our office; however, it has remained steady.

The office responded to landlord/tenant law inquiries by making the brochure *Legal Tactics* available. *Legal Tactics* is produced by the Massachusetts Law Reform Institute.

Programs
Faculty Residents in Residence Halls
Three searches were conducted to replace departing Housemasters.

Vernon and Beth Ingram left Ashdown House after sixteen years. They were replaced by Terry and Ann Orlando. After five years at East Campus, Jed Buchwald turned over his post to Julian and Marjorie Wheatley. After sixteen years ar MacGregor House, John and Carole Wilson were replaced by Charles Coleman and Kecia Brown.

Fraternities, Sororities, and Independent Living Groups
Three hundred, thirty students joined Fraternities, Sororities, and Student Living Groups (FSILG) during Orientation. Leadership development programs have increased significantly, including development of the first all FSILG leadership retreat, first joint executive board transition retreat for all three umbrella organizations, and initiation of 2002 preparation training program. The Faculty Advisor Program was developed and initiated, with five Faculty joining the program. The AIFC voted to change their name and charter; the new Association of Independent Living Groups (AILG) is working to encourage more collaboration and reach out to younger alumni. Collaboration emerged between MIT, the InterFraternity Council, and the Cambridge License Commission to more effectively create educational opportunities for houses that violate policies. The CLC's Kappa Sigma Fraternity disciplinary hearing decision dated December 11, 2000 served as the template for the development of this new collaborative model. Advising for traditionally minority Fraternities and Sororities has been integrated into the new advising team. The Panhellenic Association 2002 Committee produced its final report which was approved. Recruitment after the 2002 transition in residence selection will be less than two weeks long and begin on the last day of IAP. The InterFraternity Council 2002 Committee has set its schedule for recruitment in 2002. Official recruitment will last for two weeks, beginning at the end of the second full week of the fall term. There will also be a spring recruitment period. The InterFraternity Council revamped its constitution to enable increased functioning and recognize emerging needs such as Inter-FSILG relations and recognition of the Living Group Council. The Panhellenic Association significantly evaluated its role within the FSILG system at MIT. Event planning and visibility efforts,

along with increased leadership and participation marked this year's progress. Sigma Alpha Epsilon sold their Boston properties with the intent of establishing a foundation. Recolonization remains a possibility. The InterFraternity Council was awarded the "Council Management Programming Excellence Award" and the "Leadership and Educational Development Programming Excellence Award" by the Northeast Greek Leadership Association (NGLA).

Lesbian, Bisexual, Gay, and Transgendered at MIT (lbgt@MIT)
The mission and primary goals of lbgt@MIT and the LBGT Issues Group were evaluated and updated to reflect new levels of focus. New programs and services this year included an alumni-student mentoring program, the Lavender Graduation Reception cosponsored by BGALA, and SpeakOUT, a two-day training hosted by MIT. GaMIT led an effort to bring the Fierce Forever IV drag show to campus. LBGT organized a poster campaign featuring LBGT and supportive members of the MIT community to raise awareness and increase visibility. Since 1996, primary financial resources for LBGT programs and services were provided by John S. W. Kellett '47, whose $100,000 pledge to MIT and BGALA is now complete. The Office of the Dean for Student Life has committed to institutionalizing this financial support. The New Institute award was established in honor of John S. W. Kellett '47, to be given annually in recognition of exceptional commitment to creating a welcoming environment at MIT. The Undergraduate Association committed $2700 to found a Gay Resource Center. Volunteer efforts continued to provide the majority of efforts to support lbgt individuals, continuing to cause concern regarding sustained and ongoing services.

Public Service Center
The Public Service Center (PSC) has begun implementation of a mission that goes beyond Cambridge public education to also encompass national and global issues.

CityDays drew over 500 MIT students. The ninth annual MIT-Cambridge Science Expo brought nearly 300 seventh and eighth graders to MIT with 150 student volunteers to tour Institute labs. Seventy-five MIT students volunteered through LINKS to assist in Cambridge science classrooms. The Reach Out—Teach a Child to Read program provided nearly 100 MIT mentors to children learning to read. KEYs ran 5 one-day workshops and a three-day summer program involving 120 girls and over 30 MIT women mentors. The Giving Tree and collaborative gift and clothing drive provided over 1500 gifts to needy children from 14 area agencies. A new program, CommuniTech, was founded to address digital divide issues. Three new Fellowships were created: Vector, Educational Outreach and International Service. Fellows engaged students in science, researched possible models for math and science support to enable MIT volunteers to work productively with public school students, and traveled to Guyana to establish an optical lab and eyeglass-recycling center. A new $10,000 Coop Grant fund was created in partnership with The Coop to support student community service projects. Along with Edgerton Center, the PSC received a $56,000 three-year Massachusetts Campus Compact (MACC) grant to support service learning at MIT, with three pilot classes already in place. Two other MACC grants have provided successive full-time VISTA positions.

Student Activities
RLSLP provided direction and support to the first annual Undergraduate Association (UA) Councilor Retreat. Developed and offered several innovative training workshops for new student group officers. The office hosted the first-ever Student Leaders' Recognition Reception on behalf of the Office of Student Life Programs, as a way to provide more visible celebration and recognition of student leaders. Ongoing work with the Graduate Student Council, in conjunction with the Graduate Students Office and the Office of Organizational Development, is leading to the creation of a leadership development program specifically for graduate students.

The Student Activities Finances function this fall welcomed the accounts of all 60 graduate student groups that had previously been managed through the GSC. We now support 706 student group internal bank accounts. RLSLP worked with the UA to expand student organization access to funding by permitting over-allocation in response to the 30-40 percent rollover of unspent funds that has been occurring. The UA, GSC, and Student Activities reached an agreement to shift financial support of the Association of Student Activities (ASA) from the Office of the Dean for Student Life. The UA and GSC agreed to cover all ASA expenses up to $10,000, in equal shares. Requests above $10,000 would be negotiated between the ASA and Student Activities.The office streamlined the Request for Funding process and developed a Funding Guide to assist student organizations in understanding the primary funding sources on campus.

LeaderShape formally came under the direction of the Student Activities Office, and the program, now in its 7th year, was again a great success. 65 students participated in the program and 13 faculty, staff and students served as facilitators.

Spring Weekend 2001 included the largest concert ever held at MIT with 2700 tickets sold. About 300 students came to the "Kresge Kickback" barbecue and the weekend culminated with the first Odyssey Ball, sponsored by the Office of the President.

The eighth Charm School was organized. Improvements included moving the event, for the first time, to the Student Center, adding a fashion show, and updating and increasing the number of classes. An estimated 800 students attended the 28 different classes taught by over 50 faculty, students, and staff.

Supplemental Funding Allocation
Weekends@MIT distributed $45,000 to 14 individual events sponsored, at least in part, by one or more living groups, in addition to supporting Spring Weekend and Fall Festival. An additional $5,000 was provided to a Panhellenic Association sponsored carnival by the Thomas Glenn Leo '75 Weekends@MIT fund. Through the MIT Fund, $55,024.90 was allocated to 30 different groups/programs, with the largest allocation being $3,000 for any one program. The "Student Life Now" Fund began the fiscal year with $19,635 on July 1, 2000, with $12,139 in gifts made this year by parents. $25,800 was allocated from the "Student Life Now" account to support 14 different programs and events this year.

Residential Programs
A Residential Information System was designed and is currently being programmed. The system will address a variety of communication needs, including tracking housing assignments, enabling house residents easier access to house services and programs, and improving information sharing among House Teams.

Seventeen faculty members served as regular House Fellows this year, in addition to the ten who participated as First-Year Advisors and House Fellows through Residence Based Advising pilot programs.

In collaboration with the Health Education Service of MIT Medical and the Academic Resource Center, the first year of a pilot program in Residence Based Advising was completed. A team of 11 Resident Associate Advisors were trained to provide resources and support to residents of the two participating residence halls, McCormick and Random, including organization of over 50 academic, social, or wellness programs. For more information on the advising and health aspects of the program, please see the Academic Resource Center's Report.

The Kitchen Chemistry Seminar program expanded. Four courses were offered, including one in East Campus that was organized and taught by a student.

The office organized newspaper readership program in Senior House, distributing up to 70 newspapers to residents each day.

Housemasters and Graduate Resident Tutors
Two Housemasters are leaving their posts in July—Vernon and Beth Ingram from Ashdown and Jed Buchwald from East Campus. The new Housemasters will be Terry and Ann Orlando (Ashdown) and Julian and Marjorie Wheatley (East Campus). In addition, MacGregor Associate Housemasters John Wilson and Carol Espy-William resigned. Charles Coleman and Kecia Brown will become the new Associates. Steve and Laura Lerman were announced as the new Housemasters for NW30. Anne and William McCants, currently Housemasters of Green Hall, were announced as the Housemasters for Simmons Hall once construction is complete.

Twenty new Graduate Resident Tutors were hired this year from a pool of 65 applicants.

Tutor training and support increased significantly. A Tutor Advisor Board was established with one tutor from each hall to assist in programming and training development. Monthly training sessions were scheduled on topics such as depression, suicide, designer drugs, programming, crisis response, and alcohol issues.

RLSLP held first ever end-of-the-year appreciation banquet for House Teams at the Faculty Club.

Housemasters received a 55 percent increase in their discretionary accounts. In addition, each house received an additional $5,000 to support special programs.

ADMINISTRATION
Financial Structure
RLSLP underwent an extensive review of its financial structure with the intention of bringing the system to a full-costing model and integrating the finances from the two individual departments that merged two years ago to form RLSLP. The office developed and implemented a centralized budgeting system to shift fiscal responsibility to area leaders and supervisors.

PERSONNEL
The following staff changes occurred:
- Karen Nilsson promoted to Director of Housing Operations.
- Barbara Baker hired as new Associate Dean and Director of Student Life Programs (start date: July 9, 2001).
- Laura Capone promoted into a position in the Office of the Dean for Student Life.
- Carl Seagren accepted new position of Operations Manager. Financial Operations Manager role developed into an Assistant Director for Finance and IT. A search is in progress.
- Ricky Gresh promoted to new position of Assistant Director of Student Life Programs.
- Chris Nolan promoted to Assistant Director for Maintenance, Renovation, and Construction.
- Carmine LaRocca promoted to Manager for Maintenance and Renovation.

- Phil Hatchouel promoted to new position of Manager of Maintenance and Renovation. A search is ongoing to replace him as House Manager of Next House.
- Tracy Purinton promoted to Assistant Dean for Student Activities.
- Sally Susnowitz hired as Assistant Dean and Director of the Public Service Center.
- Neal Dorow, Assistant Dean for FSILGs resigned, and the advising for FSILGs was evaluated. Steven Immerman of the Office of the Executive Vice President served in an interim role until the hire of new FSILG Staff. David Rogers, Kate Baxter, Lisa Walsh, and Denise Vallay were hired into the newly created positions of Assistant Dean and Director, Programs Coordinator, Operations Coordinator, and Administrative Assistant, respectively.
- Jill Soucy promoted to Assistant Director of the Public Service Center.
- John (Jack) Ahern shifted from Senior House House Manager to NW30. Kenneth Wolff hired as House Manager of Senior House.
- Bailey Hewit-Morey accepted a new position as Administrative Assistant to support Summer Housing and Undergraduate Assignments. House Manager Derrick Barnes shifted from Bexley and Random Halls to replace Bailey in McCormick Hall. A search is ongoing to hire a House Manager to replace Derrick.
- Four Residential Life Associate positions were created, along with a support staff. The positions have been filled by Gabrielle Pardo, Tony Gray, Chandra Mincher, and Aaradhana Prajapati.
- Norma Lopez resigned as Program Coordinator for Student Activities. A search is underway.
- Andrea Lathrop took a position in the Office of the Dean for Student Life. Marie Shanahan's role shifted to support the Associate Dean and Director of SLP, and Nate Elton was hired as Administrative Assistant for Residential Programs in Marie's place.
- Leonard Wong hired as Senior Office Assistant in Student Activities after Eric Schlemann resigned. Leonard later resigned. The position is currently under evaluation.
- Eleonore Zamora hired into the newly created position of Senior Office Assistant for Off-Campus Housing.
- Hillary Parkinson and Angela Ruggiero were hired as Administrative Assistants for Graduate Housing. Angela Ruggiero has since resigned, and a search for replacement has begun. Geri-Lyn Bowen returned to Graduate Housing as a part-time Administrative Assistant.
- Jeremy Chaussee joined the Public Service Center for a full-time, one-year appointment as an AmeriCORPS/VISTA volunteer.
- Dania Palanker served as this year's Graduate Assistant for lbgt@MIT.
- The Student Conflict Resolution and Mediation function of our office became a separate Office of Student Conflict Resolution and Discipline under the Dean for Student Life.

DEAN FOR GRADUATE STUDENTS

STRATEGIC COMMUNICATIONS AND BUSINESS STRATEGIES

During the past year, the Graduate Students Office (GSO) increased the level of its strategic collaboration with the Communications Office in order to accelerate the development of products and other intermediate outcomes from the engagement described more extensively last year. Barrie Gleason, Director of Communications, remained "on loan" for the year; but her involvement increased from 25 percent time to 75 percent time, as the GSO identified a number of key business objectives on which to push forward.

The Dean's team for the communications and business strategy work included Barrie Gleason, Associate Dean Blanche Staton, and the Dean. However, our efforts this past year have relied on our success in supporting the ongoing involvement of numerous collaborators across MIT, individuals and groups who have committed counsel and resources to help improve the GSO's services for graduate students while also addressing specific interests of their own operations. Such enlightened mutual support and assistance reflected the essence of the "collaborative leadership" model espoused and implemented by the Dean and by Executive Vice President John Curry. In the prior academic year, AY1999, the Dean participated in the collaborative leadership workshop that was co-facilitated by Executive Vice President John Curry and Director of Organization and Employee Development, Margaret Ann Gray. This was followed by the Dean leading a second workshop, which brought together approximately twenty collaborators to develop specific, mutually beneficial projects and to negotiate responsibilities for their implementation. That effort produced the collaborative projects that were described in last year's report. Those projects moved forward during the past year and will be reviewed below. The Dean plans to hold a third workshop in the fall of 2001, to review and celebrate the ongoing work and to thank participants for their trust and involvement.

An important product that was developed and completed in the past year was the *Quick Reference Guide* to GSO services and staff. This long-awaited document has been printed and distributed to graduate administrators this past year. For the coming fall term, copies will be made available during orientation week for all incoming graduate students, and additional copies will be placed in each graduate residence hall.

The proposed new GSO web presence took major steps towards completion. In collaboration with the Publishing Services Bureau, the GSO hired web designer Kyong Choe and programmer Robert Wilt for technical assistance in developing the new web site. June 2001 was the initial target date for completion of Phase 1 of the site, an expanded and more functional administrative web facility (as opposed to a facility focused on outreach to prospective students). However, by the beginning of the past summer term, it became clear that re-organizing and bringing additional clarity to information in the Graduate Education Manual would require more time. Thus, the target date for the web site's on-line debut was revised to September 1, 2001. Future revisions of the manual will incorporate rules, regulations, and policies that are currently distributed among several other publications, including *Policies and Procedures*, the *Faculty Policy Manual*, and the *MIT Bulletin*. We expect to bring together all of the information relevant to graduate students, resolve discrepancies, and provide some explicit rationale for existing graduate policies and procedures. This information resource will be maintained on the web.

In the past year, the Dean's team completed additional focus group discussions with faculty, students and alumni/ae, for a total of seventeen groups over the past two years. Information from these sessions was analyzed to distill and articulate a set of themes or messages that we believe characterize critical aspects of the graduate experience at MIT. Rather surprisingly, many of those statements were focused internally as messages to the internal audience about ways to further enhance the graduate experience. Others were directed towards strengthening MIT's ability to attract students into our graduate degree programs.

The Dean's team submitted an article to the *Faculty Newsletter* describing the nature of the GSO's communications and business strategy work over the past two years. An important focus of the article, "News from the Dean," was to emphasize the growing need to build and maintain graduate communities on campus. Later during the academic year, *Technology Review* published an article on the GSO's efforts to reach out to graduate students.

In May, Deans Colbert and Staton, along with Barrie Gleason, were invited to give a presentation on the GSO's communications agenda at the spring meeting of the "Ivy League Plus" association of graduate deans. A key idea discussed in the meeting was how the development of a communications strategy can help to reposition and strengthen the role of the graduate school in university affairs. Also emphasized was the essential role of strong and effective collaborations across reporting lines as a means of enhancing the impact of the graduate agenda and solidifying long term support for graduate student needs.

COLLABORATION WITH OTHER AREAS

In a series of five workshops held throughout the fall term 2000, Dean Colbert and Professor Steven Lerman (Director of the Center for Educational Computing Initiatives and former Chair of the Faculty) inaugurated Grad School 101. Co-sponsored by the Graduate Student Council, the series is directed primarily at entering graduate students, to give them practical guidance about basic survival issues as they proceed towards their degree objectives. Among the topics covered were developing effective advisor-advisee relationships, funding options and resources, issues for international students, and doctoral versus master's degree considerations. The series was very well

received, and will be repeated in the fall term 2001. The GSC has posted seminar materials on its web site, for broader availability. As the seminar series develops, the topic outline will be augmented with references, additional topic notes, and links to other relevant information. Over time, we expect that graduate students will use the Grad School 101 material to self-educate about basic survival issues and be better able to negotiate the graduate education process.

In collaboration with the MIT Women's League and the Spouses and Partners at MIT, the GSO held the second Celebrating Graduate Women event designed to recognize the presence of women graduate students. The event was held in Lobby 13 and drew a crowd of several hundred students, along with faculty and administrators. It appears to be an effective tool to promote networking among graduate women and to build a greater sense of community among them.

The collaboration with Admissions on a graduate admissions database, begun in the prior year, produced a set of data fields that were added to the Admissions database. These fields permit the GSO and the departments to better track the effectiveness of GSO recruitment activities. With these fields, applicant contacts can be tagged in the database and information recorded that might help departments with their admissions decisions. The GSO will now be able to discern which contacts from recruitment trips have led to admission offers.

Ongoing discussions with staff of the Alumni,-ae Association led to a number of national and international focus group discussions to gather alumni/ae views about graduate education and graduate community at MIT. Dean Colbert met in Hong Kong with one group. Other group discussions were held at the Alumni Leadership Forum last fall and with a group in New York City.

The GSO continued its discussions with the communications team in Resource Development to ensure that campaign publications reflect the graduate student experience.

Ike Colbert

PROGRAMS AND SERVICES FOR GRADUATE STUDENTS

Over the past three years, graduate women students have come to view the Graduate Women's Group (GWG) of approximately 50 members as an essential source of support for graduate women. Moreover, graduate administrators and counseling and support staff across the Institute have increasingly referred to this group those women students who either need to feel more connected to other women or seek a "safe place" to unburden. Throughout the academic year, the biweekly informal lunch discussions brought together women graduate students across disciplines to share world views and gain insight into their own lives. These women, representing diverse cultures and professional interests, have embraced and been enriched by their differences. The lunch discussions were student directed, and topics ranged from the challenges of balancing personal or family life and work to strategies for communicating effectively with lab supervisors and peers and managing conflict. Typically, approximately 20 to 25 students participated in the discussions, which were facilitated by the Associate Dean for Graduate Students and a program administrator from the Office of Counseling and Support Services. Occasionally, administrators from offices that provide important services to students were invited to provide information to and get feedback from the students. This year, in response to repeated expressions of interest from GWG participants, the GSO sponsored a workshop on financial planning for women. Ms. Sheila English of Solomon Smith Barney delivered a powerful two-hour presentation on money, investing, and financial planning to 35 graduate women. Participant evaluations of the presentation clearly indicated strong satisfaction with the event and a desire for similar workshops in the future.

This past year, the GSO experienced a significant increase in student attendance at the Power Lunch, a monthly series of luncheon seminars. Twice as many graduate students of color, for whom this forum is intended, took advantage of opportunities for professional and personal development. In addition to the traditional seminar themes such as managing advisor relationships, preparing for qualifying examinations, and managing stress, two investment experts from Prudential Securities gave advice on "Building Your Future and Creating Wealth." Additionally, Dr. Clarence Williams spoke about his book *Technology and the Dream: Reflections on the Black Experience at MIT 1941-1999.*

In collaboration with the Family Resource Center and Spouses and Partners at MIT, the GSO sponsored the Graduate Moms Group, informal lunch gatherings that provide an opportunity for graduate women who have children to begin to build relationships with each other, share experiences and insights, and learn about resources of particular benefit to them. Throughout the year, the Dean and Associate Dean met and corresponded with graduate women who are parents to assist and support them in identifying, prioritizing, and articulating their unique issues and concerns.

The GSO continued to sponsor the annual Welcoming Reception for New Graduate Women and Students of Color to introduce new graduate women and students of color to peers and to resources on campus. Participation by administrative and student service offices increased, with twelve operations involved this past year.

The GSO invited two well known speakers to campus to augment the Grad School 101 series and to offer their unique views on how to achieve success in graduate school. Dr. Howard Adams, former executive director of the

GEM Fellowship Program, spoke to a diverse graduate audience on "Negotiating the Dissertation Maze," and to an exclusively undergraduate audience on "Why Graduate School." Following his presentations, Dr. Adams spent an entire afternoon meeting individually with students

Dr. Calvin Mackie, assistant professor of mechanical engineering at Tulane University, shared his views on the "Road to Success" as it pertains to succeeding in graduate school.

Blanche Staton

MIT Summer Research Program
This past summer, the MIT Summer Research Program celebrated its fifteenth year of operation. With twenty participants and one guest representing fifteen schools nationwide, the program once again experienced great success. The program's guest was recommended by faculty in the Media Laboratory, who identified a talented intern through their network of colleagues. Nineteen faculty members representing thirteen departments, laboratories, and centers participated in the program. Many of these faculty hosts have previously served as mentors and continue to offer their support and encouragement to cohorts of summer interns. We are grateful for their ongoing commitment to the program.

Roy Charles

Because of significant new developments in financial and student support systems, it has become increasingly important that GSO staff be cross-trained in a number of operational capabilities. The goal is to have at least two staff who are proficient in areas essential to day-to-day operations in the central office. Thus, during the past year, financial administrator George Brennan trained both Heather Fry and Ed Ballo to monitor cost objects via the SAP system. George is a member of the SAP Users Group and attends meetings regularly. He has also been involved in usability testing. We are now more confident of the office's ability to carry out its essential functions when there are illnesses or absences due to vacations or personal emergencies.

FELLOWSHIPS OFFICE

Overall, the Fellowships Office had a productive and busy year, with frequent and effective interactions with graduate administrators regarding a significantly larger group of students coming to MIT with competitive, prestigious fellowships and grants. The challenge ahead will be in further strengthening those interactions and in continuing to provide timely, efficient, and effective services to a growing number of fellowship recipients.

In the past academic year, the number of National Science Foundation Fellows enrolled at MIT increased dramatically, from 202 in AY2000 to 291 in AY2001. This represents the largest number of NSF Fellows ever enrolled at MIT and maintains the Institute's status as one of the most sought after graduate schools for winners of these competitive awards.

During the past year, MIT also saw an increase from six to 12 in the number of students holding the Jacob Javits Fellowship.

A major highlight of the year was the increase in National Defense Science and Engineering Education Grant (NDSEG) Fellows, nearly doubling, from 24 to 46.

The Fellowships Office continued to work with Professor Lori Breslow to provide a fall workshop for new teaching assistants, and with Fred Crowley to provide tax workshops for graduate students. These ongoing services remain popular and well attended.

Brima Wurie

GRADUATE STUDENT COUNCIL

The Graduate Student Council (GSC) had a productive and successful year addressing graduate student needs. Several initiatives begun by previous GSC officers came to fruition, with the assistance of administrators across the Institute and with the collaboration and support of individual deans, officers, and student-group leaders. These successful initiatives have resulted in the development of new programs and the enhancement of continuing programs to build and maintain a strong graduate community at MIT.

Financial support from individual deans and offices has continued to be critical to the success of GSC activities. However, we recognize that the Institute cannot meet all of the funding needs. Still, the GSC was able to increase substantially its funding of graduate student groups and activities through the Funding Board, the Personal Development Series, and the Travel Grant Program. This increase resulted from the highly successful MIT Career Fair 2000.

The GSC welcomed Emmi Synder to the administrative office. Emmi serves as the GSC's new financial administrator and has responsibility for financial transactions and for additional support to student coordinators.

Through her work, the GSC will be better able to advocate for graduate student needs, to more effectively interact with internal and external supporters, and better coordinate the organization of events.

Near the end of the past academic year, three significant activities occurred, which point to future initiatives on which the GSC might focus:

- The Committee on Student Affairs met to discuss how to make MIT a better place for students. While its initial focus was on undergraduate life and learning, its interest shifted to include graduate students. This was a welcome occurrence, emphasizing the need to address graduate student concerns in this area.
- The Medical Department established a focus group for undergraduate and graduate students to collect input about improving its services for all students.
- A group of graduate students participated in the drafting of a "student bill of rights," a project initiated by undergraduates that dovetails with the GSC's interest in revising the statement of "Rights and Responsibilities of Graduate Students."

Accomplishments this year included the following:

- Stipends were increased by approximately six percent during the past year, with significant input from GSC officers.
- The availability of graduate housing is scheduled to increase with the ongoing development of 224 Albany Street as a residence hall. The GSC has worked with administrators to establish the rent structure.
- Improvements were recommended and implemented in the graduate housing lottery.
- The Saferide route was expanded to cover additional locales where graduate students live.
- The GSC allocated $1,000 to the Technology Children's Center scholarship fund to enhance affordable child care for graduate student families. The added funds raised the scholarship fund to approximately $10,000.
- The Grad School 101 seminar series was initiated, co-facilitated by Dean Colbert and Professor Lerman.
- A new program was established to provide additional mentoring to international students.
- The GSC completed its Institute-wide study of advising and delivered its report on best practices to various audiences, including the Academic Council and the faculty lunch meeting.
- The TechLink Committee was established with the School of Management, and several large events were executed. Among the most significant was the "Hacklink 2000 Iron Chef Party," which was coordinated to include visiting prospective graduate students.
- The MIT GSC was honored with two national awards at the annual National Association of Graduate and Professional Students (NAGPS). Moreover, four members of the GSC were elected to leadership positions in the organization.
- Numerous physical improvements were implemented in the GSC office, making it a more pleasant and effective place to work.

Maria Raposo

INTERNATIONAL STUDENTS OFFICE

The mission of the International Students Office is to help the international student population at MIT fulfill their academic goals by providing services and support programs that facilitate adjustment to a new academic and cultural environment. The office assists students in maintaining their legal status in the United States, provides support for their dependents, and promotes their interaction with and integration into the MIT community at large. In addition, the ISO interfaces with all MIT offices, advocating for awareness in the community of issues salient to the MIT international student.

Development of the ISO integrated database in order to comply with the 1996 Illegal Immigration Reform and Immigrant Responsibility Act (IIRIRA) continued to be a major area of focus during the 2000–2001 year. While the ISO continued its routine work with respect to legal admission, orientation, advising, and programming for international students, all efforts were set against the backdrop of the impending implementation of the Student Exchange Visitor Information System (SEVIS, formerly known as CIPRIS). In addition to complying with federal mandates, an integrated database will also allow the ISO to streamline and even eliminate some of its more routine, labor-intensive tasks, thereby affording the office the ability to expand and improve its services.

ADMISSIONS

The ISO continues to play a pivotal role in Admissions, which enables international students admitted to MIT to secure their visas, arrive in a timely fashion, and be both culturally and legally oriented to life in the US and at MIT.

This year, graduate admits from the Peoples Republic of China (PRC) faced unusually rigorous scrutiny at the US Embassy and Consulates. A majority of newly admitted PRC students had visas denied on first and second attempts. The ISO spent an inordinate amount of time walking through the visa interview process with admitted PRC nationals by phone or via email. MIT faculty consulted us frequently as they drafted appeal letters to consular officials for their students whose visas were denied. (Peer institutions across the country experienced the same trend in PRC student visa denials during the spring and summer of 2001.) Ultimately, with extensive intervention on the part of ISO staff, we were able to get all but two of our PRC admits into the US in F-1 student immigration status.

Admission numbers continue to increase steadily, with the M.Eng. programs and the visiting student category especially appealing to foreign nationals. Visiting students have been a particularly thorny group to handle from both a legal and an advising perspective. They often arrive with little or no notice, and frequently with inappropriate immigration statuses. The ISO has a clear procedure in place but because agreements are often made between the inviting faculty member and the individual prospective visiting student, critical legal steps can be overlooked, creating serious immigration fallout. On the advising side, visiting students have come to us because they have had problems competing with regularly enrolled MIT students for physical space in labs and departments. They have difficulties finding accommodations in the Cambridge area since they are not entitled to on campus housing. Issues have also arisen with respect to the unresolved library fines and medical bills of visiting students.

The inaugural group of 33 Cambridge-MIT Alliance (CMI) students arrived on campus during the summer of 2001. The ISO prepared special immigration documents to accommodate the unique aspects of this program, in addition to designing a customized immigration orientation program. CMI students will be required to attend this session prior to registration at MIT. According to Associate Dean Margaret Enders, CMI expects to expand its number of participants substantially each year.

As every new program and alliance has its own admission idiosyncrasies, the ISO has become proficient in applying legal admissions requirements to new realities. OpenCourseWare and other new distance learning initiatives will undoubtedly have unique immigration and advising ramifications for the Institute.

ADVISING

Advising remains at the core of the ISO's responsibility to the international student. Thousands of students have received advice on immigration procedures and regulations for traveling, employment, and change of visa status. By individual appointment, as well as through the use of increasingly more sophisticated web site and email, prospective students, admitted students, current students, and graduated students (who seek our counsel long after commencement), the three advisors have been kept busy providing legal and personal advice. While ostensibly seeking ISO expertise because INS regulations require it, students also come to the ISO with underlying concerns about cultural adjustment and worries about political tensions back home. In this important advising role, the ISO is a place to seek technical information, clarification, advice, comfort, and even protection. Mental health issues, domestic violence, and academic honesty continue to be areas of great concern for our international students. It is imperative that the ISO find the resources and staff time to develop programming around these critical issues.

As in the past, advisors have continued to visit students who have been hospitalized, comfort students grieving the loss of a loved one back home, and intervene on behalf of troubled students with immigration, consular officials, and other government agencies.

ORIENTATION PROGRAMS

All international students, regardless of age, degree program, or familiarity with life in the US, undergo a period of cultural adjustment. They and their dependents require information about their new surroundings, culture, and community. We have devoted a special section of our web site to incoming international students, updating it frequently. Through the extensive use of the Web and e-mail, incoming students are now able to address many of their practical concerns prior to arrival to the US. Once students arrive on campus, we have provided individual and small group orientation sessions to all incoming internationals, daily from mid-August to mid-September. The ISO is in fact legally required to provide immigration information to all new students and to verify that they are in appropriate legal status. We have expanded this mandated orientation to include overall orientation to Boston and MIT culture. Complementing our required orientation were a number of social events open to the entire international community. These events have included coffee hours, presentations by the Medical Department, the MIT Libraries, and Campus Police. Orientation culminated with an international student panel, a faculty panel, and the International Open House. The ISO continues to be solely responsible for Undergraduate International Orientation, with some support from the Academic Resources Office and the freshman orientation staff. The ISO staff and international upperclassmen worked together this year to welcome new students with events such as a pancake breakfast, a Boston "Duck" Tour, an international barbecue, and a cross-cultural workshop. We hope to secure funding to augment this type of programming in the future. Our events were so personally appealing that a significant number of domestic incoming freshmen attended.

HOST TO INTERNATIONAL STUDENTS

The HISP has remained vital in providing new students with supportive emotional and social ties to the MIT community. Kate Baty, coordinator of the program, has been tireless in her efforts to develop and implement new programs and events. In addition to the traditional "welcome barbecue" for new students and their host families, Kate and the ISO staff organized potluck dinners for students and host families, which encouraged and solidified cross-cultural relationships within the MIT community. Kate continued to be actively involved with the International Freshman Mentor Program, which matches incoming international freshman with upperclassmen before they arrive. The relationship develops between student and mentor, with airport pick up and a bevy of social activities and mentor-organized programming during the first few months after arrival. The Mentor Program has been staffed and organized entirely by volunteer students, along with volunteer co-founder Paulette Schwartz. As we begin the third year of the program, we have found that the original protegees provide the program with a pool of committed

mentors for the new incoming class, a true testament to the success of the program. The ISO will seek ways, financial and other, to support and expand this invaluable initiative.

IAP ACTIVITIES

The ISO continued to offer and sponsor workshops of special interest to MIT international students during IAP. Options for internships and employment in the US have always been of great concern. Danielle Guichard-Ashbrook presented two workshops covering the laws that regulate the employment of F-1 and J-1 student visa holders as they relate to jobs at MIT, summer internships off campus, and employment possibilities after graduation. A prominent Boston area immigration attorney presented an informative talk on future visa options when student visa eligibility ends. MIT's Assistant Controller Fred Crowley once again presented a critical workshop about federal and state tax filing requirements for international students. All of these IAP workshops were extremely well attended, with some oversubscribed.

STAFFING

In January 2001, Danielle Guichard-Ashbrook was named Associate Dean and Director of the International Students Office. Maria Brennan was named Assistant Director. Sandy Lo was hired to fill the permanent third International Student Advisor Position in the ISO. Kate Baty has ably continued as Host Family Coordinator and also provides personal counseling and support to many undergraduate internationals. Carlene Green-Paul serves as the critical support staff administrator for both international undergraduate and graduate admissions. During the 2000–2001 year, we were finally able to secure a full-time receptionist position for the ISO. This position, filled ably by Anita DiMarco, has been absolutely critical for the welcoming and efficient delivery of our services to the public. Andrew Wang, our Technical Support Specialist, in addition to providing the ISO with superb technical expertise, is also taking on an advising role due to the increasing number of international students who need immigration guidance. Joycelyn Thompson, our seasonal admissions support staff whom we share with the Department of Electrical Engineering and Computer Science, was particularly helpful this year in processing a variety of immigration documents and support letters.

Danielle Guichard-Ashbrook

VICE PRESIDENT AND DEAN FOR RESEARCH

The areas that report to the Vice President and Dean for Research include the departments in the Whitaker College, and the interdisciplinary laboratories, centers, and programs.

The Vice President and Dean for Research continues to sponsor annual seminars on research practice aimed at clarifying the range of acceptable practices in conducting research. These seminars bring together faculty, professional research staff, postdoctoral associates and fellows, and graduate students to discuss topics such as mentorship, authorship, and secrecy in science. They are moderated by Dr. Stephanie Bird, Special Assistant to the Vice President for Research, and participation is Institute-wide by invitation.

ORGANIZATION AND PERSONNEL CHANGES

Professor Jefferson Tester stepped down from his position as Director of the MIT Energy Laboratory on June 30, 2001. On July 1, the MIT Energy Laboratory and the Center for Environmental Initiatives will merge to create the Laboratory for Energy and the Environment with Professor David H. Marks as Director. Professor Marks has been the Director of the Center for Environmental Initiatives.

Effective January 1, 2001, Professor Michael F. Rubner became the Director the Center for Materials Science and Engineering. Effective February 1, 2001, Professor Jeffrey H. Shapiro became the Director of the Research Laboratory of Electronics.

More information about this organization can be found online at http://web.mit.edu/vpr/www/.

J. David Litster

WHITAKER COLLEGE OF HEALTH SCIENCES AND TECHNOLOGY

CENTER FOR ENVIRONMENTAL HEALTH SCIENCES

For the last twenty years the Center for Environmental Health Sciences has been directed by Professor William Thilly, and during that time the faculty affiliated with this center has explored a broad range of questions relating to whether and how environmental agents are detrimental to human health. These questions have ranged from measuring chemical contaminants in river sediments and examining how these contaminants accumulate in the environment, to examining patterns of cancer induced mortality in population based epidemiological studies. In between these two extremes, the question of whether environmental agents have the potential to affect human health has been addressed using a wide variety of model biological systems. Such model biological systems are amenable to genetic, biochemical and other kinds of experimental manipulation, thus enabling the exploration of how environmental agents affect living organisms at many levels. In the last few years the endeavors of the center have become very focused upon the analysis of cancer mortality data and the measurement of mutations in human cells and tissues.

On September 1, 2001, Professor Leona Samson was appointed as director of the Center for Environmental Health Sciences with the charge of revitalizing and reorganizing the center. This presents a tremendous opportunity to assemble a diverse faculty to address issues of how environmental agents impact biological systems. For the past 25 years, Dr. Samson's own research has focused on how cells, tissues and animals respond to environmental toxicants, using a diverse set of approaches, including x-ray crystallography, biochemistry, microbial genetics, mammalian cell genetics, gene therapy, mouse knock out technology, genomics, and human population based studies. Professor Samson is joined by Professor Pete Dedon, a world-renowned expert in structural and biological aspects DNA damage and repair, as Deputy Director of the center. Their immediate plans are to establish at least five research cores within the center, plus three facilties cores. These are briefly described below.

The Research Cores include the following:
Professor Dedon will direct the Radiation Biology Research Core by bringing together a number of MIT faculty from several departments who are currently working in this area. This group plans to submit a Program Project Grant application in the Radiation Biology research area during the coming year.

Professor John Essigmann will direct the Mutagenisis and Carcinogenesis Core, again bringing together a number of MIT faculty already working in this area. We expect significant synergy and new collaborations to emerge from bringing these faculty members together. Indeed we expect this to be the case for each one of the five research cores.

Professor Linda Griffith will direct the Bioengineering for Toxicology Research Core, bringing an entirely new perspective to Environmental Health Sciences. Her bioengineering perspective will open up new avenues of research, and one of the goals of this core will be to explore possibilities for replacing animals with engineered tissues to test whether environmental agents are detrimental to biological systems.

Professor Harry Hemond will direct the Environmental Chemistry and Microbiology Research Core, which will again involve faculty from several MIT departments. This represents a continuation of the quantitative assessment of environmental contaminants, but also extends to considering the role of various microbes in the environmental as spearheaded by Professor David Schauer.

Professor Steven Tannenbaum will direct the Biomarkers Research Core, drawing on his extensive world-class research in this area. Once again this core will draw faculty from across the MIT campus, and in particular will engage a number Bioengineering faculty who are bringing a new perspective to this research. Finally, Professors Heidi Nepf and Patricia Culligan will continue to direct the Community Outreach Core.

The Facilities Cores include the following:
Doctors Art Lafleur and Peter Wishnok will direct a reorganized Mass Spectrometry and Analytical Core. Dr. Elena Gostjeva will direct a Cell and Molecular Imaging Core, and we plan to hire an experienced pathologist as co-director. Professors Samson and Sorger will direct a Genomics and Bioinformatics Core.

It should be noted that there has been a recent influx of new funding into the Center for Environmental Health Sciences. In particular, a very large program project that applies genomics approaches to exploring how cells, animals and humans respond to environmental agents was recently awarded. This represents an excellent beginning to launch the reorganization and revitalization of the MIT Center for Environmental Health Sciences.

More information about the Center for Environmental Health Sciences can be found online at http://mit.edu/cehs/.

Leona D. Samson

CLINICAL RESEARCH CENTER

The Clinical Research Center (CRC) was established in 1964, with grant support from the National Institutes of Health (NIH), to provide a facility in which Massachusetts Institute of Technology (MIT) investigators and their collaborators could apply the Institute's expertise in basic biochemical and biophysical mechanisms to the analysis of normal and pathologic processes in humans. MIT's CRC was the first federally supported clinical research center located in a university and not within a hospital, and remains one of only two or three such centers. It was anticipated that in spite of its university venue, a large number of qualified physicians and clinical scientists from MIT's faculty and staff would utilize the CRC to study normal volunteers, or patients with chronic diseases.

Scientists and physicians authorized to carry out research protocols using the CRC's facilities include: professors; research scientists who work exclusively at MIT; and those with primary appointments in local medical institutions whose research interests overlap extensively with those of MIT investigators. Research protocols must be approved by the MIT Committee on the Use of Humans as Experimental Subjects (COUHES) and the CRC Advisory Committee before they can be implemented. The CRC Advisory Committee, chaired by Dr. Daniel Shannon, Professor of Pediatrics at the Harvard Medical School and Professor of Health Sciences at the Harvard/MIT Division of Health Sciences and Technology, consists of ten voting members plus nine non-voting members from the CRC's program and operating staffs. The committee has reported to the Principal Investigator of the CRC's NIH Grant, Martha Gray, Professor and Co-director of Harvard/MIT Division of Health Sciences and Technology (HST). With the CRC's administrative merger with the Massachusetts General Hospital's CRC, it now reports (for NIH grant purposes) to Dr. James Mongan, Principal Investigator of the joint NIH grant. It meets bimonthly to evaluate protocols for their scientific quality, experimental design, ultimate statistical validity and potential risk to human subjects. The committee also sets general policies and reviews the operations of the CRC.

ADMINISTRATION

The CRC presently has a dual administrative locus within MIT. As a research unit, the CRC reports through the Harvard-MIT Division of HST to the Vice President and Dean for Research, Professor David Litster. However as a patient-care unit, the CRC is a part of the MIT Medical Department and reports to Dr. William M. Kettyle, the Director of the Medical Department. Members of the CRC participate in the Medical Department's activities; e.g., its Quality Improvement, Pharmacy and Therapeutics, Medical Records, and Safety Committees.

Several years ago the CRC was approached by the General Clinical Research Centers administration of the NIH, which funds this and all other CRC's, and asked to consider becoming a "Network" CRC. This would involve implementing at the MIT CRC some research projects generated at other local CRC's, and, conversely, implementing some of the our projects (e.g. those involving very sick patients) at those other centers. Additionally, the CRC would, where possible, coordinate the activities of the core laboratories, nutrition programs, and nursing programs, with those of other local institutions, in order to increase their efficiency. The CRC would also use this networking as a platform from which to solicit additional NIH funds, perhaps as a part of a common grant. As a consequence, the CRC has forseveral years been developing a more structured relationship with the CRC at the Massachusetts General Hospital (MGH), and this expanding relationship has, in fact, been highly successful. To date twenty-six MGH protocols have been approved and implemented at the MIT CRC, and three MIT protocols have been implemented at the MGH. The senior program staffs at the two institutions continue to meet monthly to anticipate and solve potential problems related to their gradual integration and to streamline the protocol review process; COUHES and its MGH counterpart also work together to evaluate network protocols from the standpoint of safety.

The relationship between the two GCRCs will continue to be developed and expanded, and the two centers are currently collaborating on a joint NIH renewal grant application, for five years of support, to start funding in December of 2002, when the present MGH NIH grant expires. Meanwhile, since the present MIT grant expires a year earlier (2001), MGH and MIT have jointly submitted an application for one year of funding for the MIT CRC (December 2001 through November 2002) as a dedicated supplement to the MGH grant. We will thereafter be identified as a "satellite" to the MGH CRC, but will suffer no loss of "sovereignty" or autonomy nor, based on discussions with the NIH, no decrease in funding. Recently, the NIH has notified MIT and MGH that they will fund the one year supplement.

Developing this type of "network" relationship with the MGH CRC allows the CRC to solve a chronic problem, i.e. the small and shrinking pool of medical doctors conducting clinical research in this facility, a consequence of the failure, during the last decade, of MIT's academic departments to appoint such people as professors. Most important, it guarantees the longevity of the CRC until such time as the pool again expands, and provides a source of physician scientists to collaborate with MIT biomedical scientists who hold doctoral degrees. The reputations of the two CRC's apparently are excellent, and the strengths of each institution complement those of the other. The CRC also continues to "network" with other Boston-area GCRC's (e.g., BIDMC) and all interested parties agree that the CRC should continue to do so in the future.

EDUCATION

The MIT CRC provides formal training in clinical investigation to advanced post-doctoral fellows taking a graduate degree (in clinical research) at Harvard Medical School, and to individual post-doctoral (medical) fellows working with CRC principal investigators and other researchers. It also affords opportunities to MIT undergraduate and

graduate students to participate in clinical research projects, and will provide, in 2002–003, a formal undergraduate course in clinical investigation (taught by Dr. Ravi Thadhani, an Assistant Program Director). These fellows and students utilize the CRC's facilities to initiate research protocols and participate in ongoing projects supervised by senior investigators and faculty. (See section on the Centers for Experimental Pharmacology and therapeutics.)

AFFIRMATIVE ACTION

The hiring of women and minorities continues to be a high priority commitment of the CRC. The CRC does have one continuing problem in meeting affirmative action objectives; i.e., in attracting qualified minority members. The traditional means of locating such personnel, by advertising and posting positions in local colleges, universities, medical institutions, and minority organizations, have not generated a significant response.

Of the six Visiting Scientists appointed by the CRC in 2000–2001 three were women and three were minorities. The CRC will continue its efforts to increase the pool of qualified minority applicants, as positions become available.

RESEARCH ACTIVITIES

The CRC continues to maintain major commitments to the research activities associated with three clinical areas, each led by a senior professor. These areas are: Nutrition/Metabolism (Vernon R. Young, professor, MIT School of Science), an area in which the CRC constitutes the major locus of MIT's activity, and one that is a traditional component of clinical research centers; Neurochemistry/Neuropsychopharmacology (Richard J. Wurtman, Cecil H. Green Distinguished Professor and Program Director, MIT CRC), which studies the effects of drugs, foods and hormones on brain composition and behavior, the effects of melatonin on sleep, and a set of diseases characterized by affective and appetitive symptoms (i.e., depression, premenstrual syndrome, smoking withdrawal, carbohydrate craving, obesity), which seem to relate to brain serotonin; and Behavioral Neuroscience (Suzanne Corkin, Professor of Brain and Cognitive Sciences), which focuses on the effects of diseases on cognitive and related brain functions and on genetic and other mechanisms causing neurodegenerative disorders (e.g., Alzheimer's disease). Groups collaborate on multi disciplinary projects, e.g., obesity; depression; Alzheimer's disease. However, the scope of the CRC's activities has expanded broadly. In the past year it also supported research protocols involving, for example, toxicology, pediatrics, psychopharmacology, women's health, HIV, biomedical engineering, diabetes, and neuroendocrinology. Reflecting its evolving interactions with the MGH GCRC, 15 of these projects (out of a total of 45) were directed by investigators whose primary appointments are at the MGH.

During 2000 the CRC patient census totaled 1604 outpatient visits and 54 inpatient days. The CRC branch of the NIH had provided, based on prior year's activities, support for up to 2500 outpatient visits and 253 inpatients. The decreased census could be explained by the completion of the data-gathering portions of several large projects.

CENTER FOR EXPERIMENTAL PHARMACOLOGY AND THERAPEUTICS

The HST Center of Experimental Pharmacology and Therapeutics (CEPT), based in the MIT CRC, has both an educational and research mission. This center is directed by Dr. Robert Rubin, (HST), Osborne Professor of Health Sciences and Technology. Educationally, each year 10 M.D.'s who have completed their clinical training enter a two-year program that provides both "hands-on" research experience and didactic training in clinical investigation and experimental pharmacology. At the end of the two years, after passing aqualifying examination and fulfilling a thesis requirement, the graduates receive a Master/Medical Science degree in clinical investigation from HST. A parallel program for Ph.D. scientists is in the process of being established as well. This will involve HST, the Sloan School of Management, the Department of Biology, and the School of Engineering, and will again be centered in the CRC. Research-wise, the emphasis of the CEPT has been in the application of positron emission tomography, magnetic resonance imagery, ultrasound and other measurement technologies to the development of new drugs. With the development of imaging technologies at MIT, these efforts will be greatly facilitated.

COMPUTER FACILITY

The CRC computer staff has continued to develop the CRC Operations System with the addition of systems for the Core Laboratory and the DEXA facility. These systems use an ORACLE relational database, and support the day-to-day operations of the CRC. The computer staff has also been working with their MGH counterparts to install and test the Turbo software package which will streamline the protocol application process and NIH annual reporting requirement for both CRCs. In addition, considerable time and effort has been spent on updating and improving the CRC website by instituting links to the MIT IRB protocol applications and establishing an interactive format for MIT and MGH investigators to complete their protocol applications on-line.

Researchers continue to make use of the SAS statistical software available on the CRC computer system. They also use resources available on the Internet. In addition, the computer facility provides hardware and software support for the CRC staff and investigators and statistical assistance to all researchers.

CORE LABORATORY/MASS SPECTROMETRY FACILITY

The Core Laboratory specializes in assays that directly support the research efforts of CRC investigators and are not readily available commercially. The most important and complex assays are undertaken by the Mass Spectrometry Facility, where stable isotope tracer analyses are performed. The Mass Spectrometry Facility is a shared instrument facility that allows CRC investigators to conduct human metabolic studies using stable nuclide tracers. Principal areas of investigation concern the regulation of energy substrate metabolism in health and disease, and the regulation

of whole body amino acid metabolism, with particular reference to the nutritional requirements for indispensable and conditionally indispensable amino acids. Research at the MIT CRC has made important contributions to the further development of national and international dietary standards and the establishment of sound food and nutrition policies and programs. Studies continue to examine the role of dietary arginine as a precursor of the signal transducer nitric oxide. The novel doubly labeled water ($^2H_2{}^{18}O$) method is being used to define the energy requirements for adolescent and elderly subjects, and the factors, which affect these needs. These various investigations offer new basic knowledge about the physiology of human energy substrate and amino acid metabolism and, additionally, make practical contributions to problems in human nutrition.

The Core Laboratory also utilizes high performance liquid chromatography (HPLC) techniques. A Beckman System Gold Amino Acid Analyzer HPLC provides resolution of up to 42 physiologic amino acids. Other HPLC assays include tests for choline, tryptophan, the catecholamines, cytidine and melatonin.

RESEARCH HIGHLIGHTS

Dr. Linda Bandini

Dr. Linda Bandini and her colleagues have continued their longitudinal study of the effect of energy expenditure on growth and development in pre-adolescent girls.

Annually, subjects visit the CRC for measures of height, weight, and anthropometric measures. In addition they complete questionnaires regarding their activity and dietary patterns. Girls complete the study four years after menarche. At study completion the body composition and metabolic rate of the girls are measured in addition to their annual measures. As of December 2000, 136 girls had completed the longitudinal study and 20 remained active in the study. In a subcohort of 40 girls, abdominal scans were done at menarche to measure visceral fat. In these girls, visceral fat is again measured at study completion.

Because this is a longitudinal study, the results of the study will not be available until study completion. This study will allow the investigators to determine whether reductions in daily energy expenditure or any component of energy expenditure is a risk factor for the development of obesity in adolescent girls.

Dr. Bandini is also investigating the relationship of visceral fat to diet, activity, and hormonal changes in a subcohort of girls. These studies will provideinformation on variable that may influence visceral fat deposition. Determining what factors influence the deposition of visceral fat will provide useful information for the prevention of diabetes and heart disease.

Dr. Steven Grinspoon

Dr. Steven Grinspoon and his colleagues conducted studies to determine the effects of rhIGF-I (a nutritional-dependent anabolic hormone with potent effects on bone formation) and of estrogen on bone density in women with anorexia nervosa.

A fifty percent reduction in bone density is a common manifestation of anorexia nervosa (AN). Over 50 percent women with AN will have significant bone loss. Bone loss in AN occurs at a young age, and is often resistant to improvement with existing therapies such as estrogen. Bone formation is significantly reduced in women with AN, in association with increased bone resorption. To address the mechanism responsible for decreased bone formation in anorexia nervosa, Dr. Grinspoon designed a double-blind randomized, placebocontrolled, trial of rhIGF-I. Short-term studies have shown a significant increase in bone formation in response to rhIGF-I. Recruitment for this study is ongoing and the data investigating specific predictive factors for regional bone loss in AN haverecently been submitted for publication. Studies have shown that nutritional factors, more than indices of estrogen deficiency or other estrogen-related parameters, determine regional bone loss in a cohort of over 130 patients with AN that have been screened.

Dr. Richard Wurtman

Dr Richard Wurtman and his colleagues examined the effects of giving a single dose of phentermine (15 or 30 mg, N=17), or daily doses (30 mg) for 5 days (N=8), on levels of dopamine and serotonin in platelet-rich plasma, examined at various time points (0-4 hr) after drug administration.

They found that phentermine caused significant elevations in platelet serotonin without increasing those of plasma serotonin. Inasmuch as platelets are unable to synthesize serotonin, its increase must have reflected diminished metabolism—by the enzyme monoamine oxidase (MAO). This confirmed older in vitro data showing that phentermine is an MAO inhibitor.

The demonstration that, in humans, phentermine is an MAO inhibitor probably explains why some individuals who took "fen/phen" (fenfluramine—a serotonin releaser and uptake blocker—and phentermine) developed cardiac valvular lesions. The fenfluramine blocked the ability of platelets to take up plasma serotonin, and the MAO inhibition by phentermine blocked the only other pathway available for getting rid of the plasma serotonin, i.e., enzymatic degradation in liver, kidney, etc. The transient, but repeated, elevations in plasma serotonin levels that followed probably caused damage to the heart valves, and such damage probably would not have occurred (nor has

it been seen) in patients just taking fenfluramine or phentermine alone. Unfortunately, phentermine's activity as an MAO inhibitor still is not mentioned on its label.

Dr. V. Young
Dr. Young and his colleagues have continued to explore quantitative aspects of amino acid metabolism in healthy adult humans, with particular reference to their nutritional corollaries. Studies have been completed to the effects of a sulfur amino acid-free diet on whole blood glutathione (GSH) synthesis, showing that GSH production is regulated by the dietary availability of one of its precursors, cysteine. Studies have also been completed on the kinetics and urinary excretion of L-5-oxyoproline, an intermediate of the gamma-glutamyl cycle of GSH synthesis. Both sulfur amino acid-free and glycine-free diets alter the dynamics of oxoproline metabolism and increase the urinary excretion of this intermediate which may, therefore, serve as a potential probe of the status of GSH metabolism of GSH metabolism in human subjects. Studies have also continued on the kinetic aspects of amino acid metabolism in particular adults. Studies with lysine and threonine as the test amino acids again confirm the hypothesis that the current international requirements values for the indispensable (essential) amino acids in healthy adults are far too low and support that the tentative MIT amino acid requirement pattern is an appropriate one for use in practical considerations of adult human protein and amino acid nutrition. These findings and conclusions have major significance with respect to the planning of diets and an evaluation of diets for their amino acid adequacy worldwide. They also have important implications with respect to the planning of agricultural research programs that are directed toward improving the nutritional quality of foods in humans.

More information about the MIT Clinical Research Center can be found online at http://web.mit.edu/crc/www/.

DIVISION OF COMPARATIVE MEDICINE

The Division of Comparative Medicine (DCM) provides animal husbandry and clinical care for all research animals on the MIT campus. From its inception in 1974, the division has evolved into a comprehensive laboratory animal program that provides a full range of veterinary and surgical support. Additionally, the division has a National Institutes of Health (NIH) grant for training veterinarians for careers in biomedical research. Total personnel in the division now comprises 115 individuals. In March 1998 the division moved its administrative, diagnostic, and research laboratories to the newly renovated eighth floor of Building 16. This space is contiguous to the eighth floor of the newly renovated Building 56, which also houses quarantine, diagnostic and research space for DCM. The division now encompasses approximately 115,000 square feet devoted to animal research activities. In addition a new vivarium is being planned for the new neuroscience complex.

FACILITY MANAGEMENT AND ANIMAL CARE

The average daily census of laboratory animals grew approximately six percent during FY2001. Mice remain the primary species used by MIT investigators and represent more than 97 percent of the animal population. The animal facilities support transgenic and gene "knockout" *in vivo* experiments. DCM now performs a range of transgenic services including *in vivo* embryo transfer for rederivation of mice with endemic disease which have been imported to MIT from laboratories worldwide, *in vitro* fertilization, the provision of blastocysts, genotyping of mice and the making of transgenic mice. The division has begun to develop expertise in aquaculture and now provides veterinary support to the Sea Grant Program.

RESEARCH ACTIVITIES

Current NIH-funded grants support *in vivo* study of nitrite carcinogenesis, *in vivo* study of *Helicobacter hepaticus* and tumorigenesis, *in vivo* study of the pathogenesis of inflammatory bowel disease, *in vivo* study of *H. pylori* pathogenesis, *in vivo* study of gastric cancer, and *in vivo* study of the pathogenesis of colitis. FY2001 was the thirteenth year of the division's NIH postdoctoral training grant that has been funded through year 15. There are currently six postdoctoral trainees, two of whom are enrolled in the graduate programs in the Division of Bioengineering and Environmental Health. Twenty-four trainees have completed our postdoctoral training program and 22 of them have now passed the board examination of the American College of Laboratory Animal Medicine.

DCM faculty and staff published six chapters, 25 papers and 32 abstracts in FY2001 and presented numerous research papers at national and international meetings. Dr. Fox is the senior editor of the second edition of *Laboratory Animal Medicine* which will be published in the winter of 2001 by Academic Press.

ACADEMIC ACTIVITIES

Dr. Barbara Sheppard earned board certification from the American College of Veterinary Pathologists. Dr. Arlin Rogers joined DCM as the division's second comparative pathologist in March. Dr. Melanie Ihrig was appointed Clinical Veterinarian for the animal resource program. She was formerly a postdoctoral trainee in DCM.
DCM faculty and staff taught two graduate courses in the division of Bioengineering and Environmental Health (BEH.202 and BEH.214).

COMMITTEE ON ANIMAL CARE ACTIVITIES

The web site for the Committee on Animal Care provides required forms, continuing education material and information on the CAC's activities. DCM staff in conjunction with the Committee on Animal Care has developed an on-line training program. Didactic training sessions for Institute personnel on topics pertaining to the care and use of laboratory animals are also offered. The CAC has also developed an occupational health screen for animal related

occupational health issues and periodically sponsors seminars on health issues such as zoonotic diseases. The CAC continued to distribute to other institutions in the United States and abroad two instructional videos, one focusing on the role and responsibilities of Institutional Committees for the Care and Use of Animals and the other focusing on the use of anesthesia in laboratory animals. Both are available to MIT researchers at the Division or in the Schering-Plough Library.

More information about the Division of Comparitive Medicine can be found online at http://web.mit.edu/comp-med/.

James G. Fox

HARVARD-MIT DIVISION OF HEALTH SCIENCES AND TECHNOLOGY

The Harvard-MIT Division of Health Sciences and Technology (HST) brings engineering, science, technology, and medicine to the solution of problems in biology and human health. A successful 30-year collaboration of the Massachusetts Institute of Technology (MIT), Harvard University, Harvard Medical School (HMS), area teaching hospitals and research centers, HST is a pioneer in interdisciplinary educational and research programs designed to educate outstanding minds, cultivate leaders, create knowledge, and generate cost-effective preventive, diagnostic and therapeutic innovations. It is among the largest biomedical engineering and physician-scientist training programs in the United States.

Advances in biology and technology are bringing us to an era when diseases can be treated by "engineering" the phenotype of cells and tissues—when cell, tissue, and body functions can be manipulated using strategies that affect genes, cells, and their environment so they behave predictably. Advances in the diagnosis and prevention of disease are inexorably linked to these fundamental changes in our approach to disease management. Unquestionably, success in this area requires professionals with a broad range of skills that spans the domains of science, engineering, and medicine.

HST is dedicated to integrating these disciplines into an educational program that carries engineering and the physical and biological sciences from the laboratory bench to the bedside, and, conversely, clinical insights from the bedside to the bench. HST's programs are committed to exploring the fundamental principles underlying disease, to seeking new pharmaceuticals and devices that ameliorate human suffering, and to training the next generation of physicians, scientists, and engineers to do the same. Thus, HST trains physicians with a deep understanding of the underlying quantitative and molecular science of medicine and biomedical research. HST Ph.D. students similarly acquire a deep understanding of engineering and the physical and biological sciences. This unique training is complemented with hands-on experience in the clinic or in industry.

HST's administrative home is located at the Whitaker College of Health Sciences and Technology at MIT. As one of the five medical societies at Harvard Medical School, HST also maintains an office at the medical school's quadrangle campus in Boston. HST's two co-directors, Martha L. Gray for MIT and Joseph Bonventre for HMS, report to the provost and the vice president for research at MIT, as well as to the HMS executive dean for academic programs and the dean of HMS. Richard N. Mitchell, Assistant Professor of Pathology at Harvard Medical School, serves as the division's associate director and director of student affairs.

DEGREE PROGRAMS

HST currently enrolls approximately 320 students who work with more than 200 faculty and affiliated faculty from the Harvard and MIT communities. Six multidisciplinary graduate degree options are offered, each targeted at students with different backgrounds and goals, each requiring a focused educational and research program, and each offering a different level of clinical training:

- Medical Sciences Program (M.D.)
- Medical Engineering and Medical Physics Program (MEMP)
- Speech and Hearing Sciences Doctoral Program (SHSP)
- Radiological Sciences Joint Program (RSJP)
- Medical Informatics Program (MI)
- Clinical Investigator Training Program (CITP)

RESEARCH PROGRAMS

HST's research programs involving its students, faculty, and staff reflect the mixing of cultures in applying the tools of medicine, engineering, and science to problems in human health and clinical medicine. Current research initiatives are conducted in these areas:

- Biomedical Engineering
- Functional and Structural Biomedical Imaging
- Informatics and Computational Biomedical Sciences
- Clinical Research
- Speech and Hearing Sciences
- Cardiopulmonology

EDUCATIONAL INITIATIVES

The VaNTH Engineering Research Center for Bioengineering Educational Technologies is a consortium of Vanderbilt University, Northwestern University, University of Texas at Austin, and HST. It is one of 24 engineering research centers (ERCs) funded by the National Science Foundation. The ERCs are charged with providing an integrated environment for academe and industry to focus on next-generation advances in complex engineered systems important for the nation's future. Unique among the ERCs, the VaNTH ERC focuses on the educational enterprise. Its mission is to develop the tools, curricula, and technologies that will educate future generations of bioengineers. Faculty and researchers in the VaNTH ERC are developing challenged-based learning modules that teach bioengineering content and provide an opportunity for the learner to explore the inter-connections and relationships of the selected concepts. Using the learning sciences philosophy articulated in *How People Learn* (Bransford, Brown, and Cocking, 2000), each bioengineering module is constructed to be knowledge-center, learner-centered, assessment-centered, and community-centered. All on equal footing, VaNTH focuses on four research thrusts: the bioengineering domain, learning sciences, learning technology, and evaluation and assessment. Through its educational thrust, VaNTH stresses involvement in research and educational outreach program.

BioMATRIX, a new mentoring and advising program sponsored by HST, was launched in February 2001. The program is aimed at individuals with common interests in the biological and medical sciences and engineering. Headed by HST affiliated faculty David A. Roth (M.D. '87), its goal is to foster meaningful mentoring relationships among undergraduate students, graduate students, and practitioners who include HST faculty and staff. Funded by the Alex and Brit d'Arbeloff Fund for Excellence in MIT Education, BioMATRIX is an acronym for bio/medical science and biomedical engineering, MIT mentoring, advising and tutoring in real-life issues extended over time. BioMATRIX is not intended to replace traditional academic advising, but rather to be a means of giving students the broadest possible set of contacts with basic and clinical research scientists, academic physicians, clinicians, health economists and health policy faculty, and biologists in both academia and industry. Mentors and students are introduced via faculty profiles posted on the BioMATRIX web site. Meetings are then arranged between faculty and students with common interests, ideally in the setting of the hospital or laboratory. Since its inception, BioMATRIX has held several on-campus events, and it enjoys close ties with the undergraduate dean's office at MIT.

HIGHLIGHTS OF THE YEAR

The opening of the MGH/MIT/HMS Athinoula A. Martinos Center for Functional and Structural Biomedical Imaging was celebrated on November 3, 2000, at the MGH-East NMR facility in Charlestown, the center's temporary home. HST established this state-of-the-art imaging center to foster biomedical imaging research that spans scientific disciplines from basic research to clinical investigation, and to develop medical applications for these new technologies. This new biomedical imaging center, made possible through the generosity of Marina and Thanassis Martinos, is a partnership between the HST and MGH. Its mission is to build the build the next generation of functional imaging tools; and to apply these tools to biologically, neurologically, and clinically relevant problems; to train physical, biological, and clinical scientists; and to provide a hub for interdisciplinary collaborations between MIT, Harvard, and other institutions worldwide. Facilities include low- and high-field MRI for human and animal imaging. Systems-level imaging, high-field human MRI, high-spatial and temporal functional mapping of the brain and heart, optical imaging and pharmacological imaging are some initial research areas under investigation.

In fall of 2000, the HST student body ratified the constitution of the HST Student Council, making the HST student government the students' official representative body. The newly formed HST student government aims to foster a sense of community within the diverse HST student body and to provide a transparent and efficient mode of student representation within and outside of HST. It consists of an M.D. Council, a Ph.D. Council, and a Joint Student Council. While the M.D. and Ph.D. councils address matters pertaining to their respective HST educational branches, the Joint Student Council addresses issues of concern to all students. Council leadership works closely with the HST administration. Elected student officials sit on HST, MIT, and HMS committees to ensure student input into almost all aspects of the HST experience.

The first meeting of HST's new advisory council was held in November 2000. The council was created to assist HST in achieving its strategic goals as well as to enhance the impact of the division's activities, forge new relationships, and identify potential sources of support. Joseph Ciffolillo, retired COO of Boston Scientific Corporation, Inc., and BSC's current director, serves as chair of the council.

Greg Koski (Ph.D. '77, M.D. '78) delivered the keynote address at HST's commencement exercises on June 6, 2001. Koski was appointed in June 2000 as the first director of the Office of Human Research Protections, a new office within the Department of Health and Human Services that leads efforts to protect human subjects in biomedical and behavioral research. Fourteen students graduated with Ph.D. degrees; twenty-nine students received the M.D. degree, six students received M.D. and Ph.D. degrees, and eight students received the S.M. degree. Special recognition also went to three students who graduated *cum laude* and three who were recognized with *magna cum laude*.

The 14th annual HST Forum was celebrated on March 11 at The Westin Hotel, Copley Square, Boston. This year's forum marked the 20th anniversary of HST's first graduating class in Medical Engineering/Medical Physics (MEMP). Preceding the forum events, an HST alumnae professional development workshop featured a talk by Dr. Joyce K. Fletcher, Professor of Management at Simmons College Graduate School of Management. An alumni

panel that discussed "There is Life After MEMP," was led by Deborah Burstein (Ph.D. '86), Associate Professor of Radiology at Harvard Medical School/Beth Israel Deaconess Medical Center and current MEMP student Mark D. Price. Panelists Dr. Edward Cheal (Ph.D. '86) Managing Director of Apex Surgical LLC, Lakeville, MA; Dr. Catherine M. Ford (Ph.D. '96), Managing Engineer at Exponent Failure Analysis Associates, Inc., Philadelphia, PA; Dr. Cynthia Sung (Ph.D. '88) head of the Pharmacokinetics Group at Human Genome Services, Inc., Rockville, M.D.; and Dr. Mehmet Toner (Ph.D. '89), Associate Professor of Surgery and Bioengineering at HMS/MGH made brief presentations describing their lives after graduation.

On March 12 and 13, HST presented a hands-on learning experience for participants in its symposium *Experiencing the Frontiers of Biomedical Technology*. This unique symposium brought together a diverse group of clinicians, biotech workers, lawyers, venture capitalists, and science reporters to explore techniques used in state-of-the-art biomedical technologies and to see what it takes for these techniques to have an impact on healthcare delivery. Hands-on workshops introduced participants to tissue engineering, drug delivery systems, human-machine systems, and informatics. Interactive discussions also addressed regulatory and legal issues related to biotechnology research. A plenary session, held on day two, summarized the results uncovered by the workshop's participants. Leaders in the field also discussed the art and science of biotechnology research and the outlook for possible innovations. In a talk on drug delivery systems, Dr. Robert S. Langer, the Germeshausen Professor of Chemical and Biomedical Engineering, detailed the many challenges faced by the researchers who successfully developed a chemotherapy wafer for brain cancer treatment. Addressing the future of tissue engineering, Dr. Mehmet Toner, a faculty member in HST, Harvard Medical School, and Massachusetts General Hospital, told the audience that innovations hinge on the development of a groundbreaking therapy, possibly in the area of replacement tissue for the liver or in bone. Faculty members Dr. Emilio Bizzi and Dr. George M. Church addressed the state of biotechnology in human-machine systems and in informatics, respectively. Because of the overwhelming response, plans are underway for a second symposium in March 2002. Symposium director, Dr. Elazer Edelman, will expand the range of workshops and vary the format to enable participants to attend more than one workshop.

During 2000–2001, HST encouraged the development of regional alumni chapters in Boston and New York City. New York's meeting in April was well attended and included a talk by HST alumnus David D. Ho, (M.D. '78), director and CEO of the Aaron Diamond Research Center. Additional chapters are planned for Washington, DC, Baltimore, and San Francisco.

A five-day conference to explore the characteristics and challenges of medical care in China and the US was held at MIT in June 2001. *Health Care East and West, Moving into the 21st Century* was a significant event that will strengthen the relationships between the two countries through improved understanding, professional relationships, and collaborations. HST was well represented at the conference as Nelson Y.-S. Kiang, the Eaton-Peabody Professor Emeritus of HST, chaired the conference. HST co-director Martha L. Gray (Ph.D. '86) served on the conference program committee and delivered a talk on the next generation of medical investigators and how HST has pioneered medical education for physician-scientists. Co-director Joseph V. Bonventre served on the organizing committee. Many HST faculty and affiliated faculty not only served on various planning committees, but also participated in panel discussions and session leaders. HST students also served as conference ambassadors.

Several new courses were added during the academic year 2000–2001 to enhance HST's curriculum. They include: HST.502 Survival Skills for Emerging Researchers: Responsible Conduct of Research; HST.505 Laboratory in Molecular and Cellular Sciences; HST.515J Aerospace Biomedical and Life Support Engineering; HST.588 Biomaterials and Tissue Engineering in Medical Devices and Artificial Organ; HST.935 Narrative Ethics: Literary Texts and Moral Issues in Medicine; and HST.960 Creative Writing for Physicians.

OUTSTANDING STUDENTS

The following HST students and graduates were award recipients in the last year:

- Alexandre R. Carter, seventh-year M.D.-Ph.D. student—National Medical Association's 2000–2001 Award for Medical Journalism, recognizing journalistic excellence and overall academic achievement and leadership.
- Jason L. Gaglia, M.D., *magna cum laude*—Harvard Medical School's Leon Reznick Memorial Prize.
- Neil S. Ghiso, M.D.—NBI Humanism in Medicine Award, given to a graduating student who consistently demonstrates compassion and empathy in the delivery of care to patients.
- Thomas Heldt, fourth-year Medical Engineering/Medical Physics student—MIT's Hugh Hampton Young Memorial Fund Fellowship, which recognizes broad interdisciplinary interests, strong character, and leadership skills.
- Diego E. Marra, M.D., *magna cum laude*—Harvard Medical School's James Tolbert Shipley Prize, awarded for research carried out by a medical student, the results of which have been published or accepted for publication.
- Eric M. Morrow, M.D., *magna cum laude*—Harvard Medical School's Harold Lamport Biomedical Research Prize for the best paper reporting original research in the biomedical sciences.
- David O 'Gorman, Speech and Hearing Sciences student—MIT's Poitras Predoctoral Fellowship for biomedical engineering and/or biophysics research.

- Shunmugavelu D. Sokka, fifth-year Medical Engineering/Medical Physics student—MIT's William L. Stewart, Jr., Award, presented to students who have made outstanding contributions to co-curricular activities and events at MIT.
- Ryuji Suzuki, first-year Medical Engineering/Medical Physics student—Howard Hughes Medical Institute predoctoral fellowship in neuroscience and physiology.
- Xun Clare Zhou, M.D.—Harvard Medical School's Multiculturalism and Diversity Award given to students who have done the most to exemplify and/or promote the spirit and practice of multiculturalism and diversity at HMS.

FACULTY HONORS AND AWARDS

- Louis D. Braida, Warren Professor of Electrical Engineering and Director, HST Speech and Hearing Sciences Program—co-recipient of HST's Thomas A. McMahon Mentoring Award, presented to a faculty member who not only provides scientific guidance to students, but also inspires personal growth.
- Bertrand Delgutte, HST affiliated faculty and principal research scientist in MIT's Research Laboratory of Electronics—HST's John F. and Virginia B. Taplin Award to develop laboratory exercises in neural modeling for HST's Speech and Hearing Sciences program.
- Lee Gehrke, Professor of Health Sciences and Technology—mentoring award from the Biological and Biomedical Sciences Ph.D. Program at Harvard University.
- Martha L. Gray, HST co-director and the Edward Hood Taplin Professor of Medical and Electrical Engineering at MIT—elected to board of directors of the National Space Biomedical Research Institute.
- W. Eric L. Grimson, HST affiliated faculty and professor in MIT Department of Electrical Engineering and Computer Science—MIT Bose Award for Excellence in Teaching, recognizing faculty in the School of Engineering for outstanding contributions to undergraduate education.
- Donald E. Ingber, HST affiliated faculty and HMS professor of pathology—HST's John F. and Virginia B. Taplin Award to work on creating a new biocomplexity initiative in HST. Also chosen as the Mayo Clinic's Distinguished Lecturer in Medicine for 2001.
- Isaac S. Kohane, director of HST's Program in Bioinformatics and Functional Genomics and HMS associate professor of pediatrics, and Gregory Stephanopoulos, HST affiliated faculty and MIT professor of chemical engineering, received an HST John F. and Virginia B. Taplin Award to develop a multi-institutional, HST-based training grant in functional genomics and bioinformatics.
- Roger G. Mark, Distinguished Professor of Health Sciences and Technology—MIT's Frank E. Perkins Award for excellence I graduate advising and mentoring. Also co-recipient of HST's Thomas A. McMahon Mentoring Award, presented to an HST faculty member who not only provides scientific guidance to students, but also inspires personal growth.
- Richard N. Mitchell, Associate Director (Master) of HST at HMS and HMS associate professor of pathology—HMS Faculty Prize for Excellence in Teaching, recognizing exemplary teaching in either HMS preclinical or clinical curricula.
- Lucila Ohno-Machado, HST affiliated faculty and HMS assistant professor of radiology—HST's John F. and Virginia B. Taplin Award to build an HST curriculum in biomedical informatics.
- Valerie Pronio-Stelluto, HST affiliated faculty and HMS instructor in medicine—co-recipient of HST's Irving M. London Teaching Award, which recognizes teaching faculty who have made outstanding contributions to the training of HST students.
- Shiv S. Pillai, HST affiliated faculty and HMS assistant professor of medicine—co-recipient of HST's Irving M. London Teaching Award, which recognizes teaching faculty who have made outstanding contributions to the training of HST students.
- Jeffrey P. Sutton, HST affiliated faculty and HMS associate professor of psychiatry—named team leader of new Smart Medical Systems Team of the National Space Biomedical Research Institute.
- Steven E. Weinberger, HST affiliated faculty and HMS professor of medicine—HMS 2001 Class Day Preclinical Teaching Prize.

RESEARCH ACHIEVEMENTS

The research of the HST core faculty and research staff covers a wide spectrum of biomedical areas. In addition to laboratories at HST, MIT, Harvard University, and the Harvard Medical School, research collaborations include several HMS teaching hospitals in the Boston area (including Massachusetts General Hospital, Brigham and Women's Hospital, Beth-Israel Deaconess Medical Center, Dana Farber Cancer Institute, and Children's Hospital).

BIOMEDICAL ENGINEERING

The objective of HST's effort in biomedical engineering is cost-effective replacement of cell, tissue, and organ function. Toward this end, HST researchers apply the rigors of physical sciences to problems in medicine and biology. In particular, this work seeks to understand, harness, and engineer tissues, cells, and molecules. A principle site of this effort is the Harvard-MIT Biomedical Engineering Center, located on the MIT campus. There, seven resident faculty members supervise a scientific staff of 90. An additional 70 affiliated faculty at MIT and HMS use the center's extensive facilities and resources, which support work in a broad range of integrated sciences from molecular and cell biology to animal physiology.

Elazer R. Edelman (HST '83) is the Thomas D. and Virginia W. Cabot Associate Professor of HST and Director of the Harvard-MIT Biomedical Engineering Center. Professor Edelman and colleagues in his laboratory use elements of continuum mechanics, digital signal processing, molecular biology, and polymeric controlled release technology to examine the cellular and molecular mechanisms that transform stable coronary-artery disease to unstable coronary syndromes. Tissue-generated cells, for example, deliver growth factors and growth inhibitors for the study and potential treatment of accelerated arterial disease following angioplasty and bypass surgery. The laboratory holds patents for drug-delivery devices, tissue-engineered implants, and new drug formulations.

Michael S. Feld heads the MIT Laser Biomedical Research Center, an NIH Biotechnology Resource Center housed in the MIT Spectroscopy Laboratory, which develops basic scientific understanding, new techniques, and technology for advanced biomedical applications of lasers. Fluorescence, reflectance, near-IR Raman, light-scattering spectroscopy, and low-coherence interferometry are being used for histological and biochemical analysis of tissues, diagnosis and imaging of disease, and cell biology applications. Clinical studies are conducted with researchers from the Cleveland Clinic Foundation, Medical University of South Carolina, Brigham and Women's Hospital, Metrowest Hospital, Beth Israel Hospital and New England Medical Center. Clinical studies using trimodal spectroscopy, the combined application of intrinsic fluorescence, diffuse reflectance, and light-scattering spectroscopies, have demonstrated successful diagnosis of dysplasia in Barrett's esophagus, the urinary bladder, adenomatous polyps, the oral cavity and the uterine cervix. Light-scattering spectroscopy was used to measure and image subcellular structures much smaller than an optical wavelength. Novel low-coherence interferometry techniques, which use two harmonically related wavelengths to measure optical phase, have been developed. Exceedingly small refractive index and length changes, tomographically mapped, were used to study structure and dynamics of cellular organelles. Raman spectroscopy was used to measure blood analytes with clinical accuracy and identify morphology of breast lesions. The experimental and theoretical work of this program is advancing new laser diagnostic technologies in the fields of medicine and cell biology.

Robert S. Langer, Jr., a pioneer in biomedical and chemical engineering, is studying new ways to deliver drugs, including a new microchip that can deliver drugs in a pulsable fashion. He is also researching tissue engineering and has created new approaches for creating blood vessels, cartilage, and many other tissues. He has also developed biomaterials for medicine, including plastic that slowly dissolves and releases therapeutic drugs directly to tumors. In 1996, this led to the first new treatment for brain cancer approved by the FDA in more than twenty years.

Roger G. Mark, Distinguished Professor of Health Sciences and Technology, together with colleagues at Beth Israel-Deaconess Medical Center, Boston University, and McGill University, continue to develop the new NIH-funded "Research Resource for Complex Physiologic Signals." The resource investigates cutting-edge physiologic signal processing techniques, and freely distributes extensive archives of annotated physiologic data and signal processing software to the international research community via the Internet (http://www.physionet.org). Professor Mark's group also is developing computational cardiovascular models to better understand orthostatic intolerance induced by space flight and is exploring innovative approaches to "intelligent" patient monitoring.

Frederick J. Schoen has made major investigative contributions to understanding the problems of currently available prosthetic devices and patient management strategies. He has identified, elucidated the mechanisms of, and solved several of the critical problems associated with the biomaterials and devices used clinically. His approaches have used basic biology, evaluations of clinical implants that have failed, and industrial development studies of new and modified configurations and biomaterials. Ongoing investigations are focusing on cell-extracellular matrix interactions in the mechanisms of native heart valve degeneration and as determinants of the structure-function-quality correlations in heart valves fabricated by tissue engineering methods.

Martin L. Yarmush and colleagues are contributing to several fields, including tissue engineering, gene therapy and nucleic acid biotechnology, genomic and proteomic technology, and metabolic engineering. Professors Yarmush, Mehmet Toner, and Ronald G. Tompkins are collaborating on one of the world's leading programs to establish a liver support device using hepatocytes and microfabrication techniques. In addition, in the area of tissue engineering, Professors Jeffrey R. Morgan and Yarmush are developing the next generation of skin substitutes using genetically modified cells. In the areas of gene therapy and nucleic acid biotechnology Professor Yarmush's laboratory, together with those of Professors Morgan and Arul Jayaraman, are investigating rate-limiting aspects of gene therapy and antisense therapy. Professors Yarmush, Toner, Morgan, and Jayaraman are also collaborating on a new platform for monitoring real-time gene expression using a living cell microarray, which can provide minute-by-minute information in a massively parallel format. Finally, Professors Yarmush and François Berthiaume are using the tools of metabolic engineering to investigate the complex metabolic changes that occur in chronic disease and major injury.

MIT is one of the seven original institutions participating in the National Space Biomedical Research Institute (NSBRI), the primary agency for NASA-sponsored space biomedical research. Under the direction of Professor Laurence R. Young, the NSBRI has nearly doubled in size, expanding the number of consortium members from seven to twelve, and the number of research teams from eight to twelve. In his role as an NSBRI investigator, Professor Young is leading a major new research initiative in artificial gravity. Results from these efforts will help define the limitations and benefits of various possible countermeasures to the postural instability and disorientation

problems that result upon a return to gravity after long-duration space flight. He is collaborating on other research being prepared for the International Space Station, including the MICRO-G project to provide advanced force and moment sensors, and a virtual reality experiment informed by Neurolab experience (Professors Young and Dava Newman and Dr. Charles Oman). Professor Young has also worked successfully with NSBRI and HST toward developing a new graduate program in space life sciences. His translation of Ernst Mach's *Fundamentals of the Theory of Movement Perception* will appear in fall 2001.

James C. Weaver, HST Senior Research Scientist, and his research group, have completed the initial development of a computer simulation method to transport molecules, heat, and electricity in multicellular biological systems, with potential applications in transdermal drug delivery and in understanding the response of human tissue to electromagnetic fields.

Lisa E. Freed, HST Principal Research Scientist, supervises a research team working on tissue engineering. Her research interests include cell and developmental biology, biomaterials, and biomedical engineering, and in particular the integrated use of cells, three-dimensional scaffolds, and bioreactors to engineer functional skeletal and cardiovascular tissues. The goals are to improve basic understanding of tissue development through controlled *in vitro* studies and to generate clinically useful tissue equivalents. She also participated in teaching HST.588 Biomaterials and Tissue Engineering in Medical Devices and Artificial Organs.

Chi-Sang Poon, HST Principal Research Scientist, was co-organizer (with HST affiliated faculty Dr. Homayoun Kazemi at Harvard Medical School) of the international Conference on "Frontiers in Modeling and Control of Breathing," held on October 11–15, 2000 in North Falmouth, Massachusetts. Jointly sponsored by the Whitaker Foundation, the American Physiological Society, the Physiology Society in the UK and other sources, this triennial event extends an acclaimed tradition that began at Oxford University more than two decades ago. Drs. Poon and Kazemi were also co-editors for a pre-conference special issue of the journal *Respiration Physiology* on a similar topic, and a post-conference book published by Kluwer Scientific/Plenum Publishers based on the conference proceedings. In a paper published in the *Proceedings of the National Academy of Science*, Dr. Poon and a former associate introduced a novel *numerical titration* technique, whereby the intensity of chaos can be measured by its so-called titration strength against added noise. This finding confirmed their previous findings that subtle heart-rate variabilities are not simply random fluctuations, but are complex yet deterministic patterns that are probably chaotic. This technique may find wide applications, including the identification and control of cardiac arrhythmia, epileptic seizures, or other biomedical variables.

Gordana Vunjak-Novakovic, HST Principal Research Scientist and Adjunct Professor of Chemical Engineering at Tufts University, is supervising research teams working on tissue engineering of skeletal and cardiac tissues, and biological research in space. Her research interests include tissue engineering, bioreactors, and transport phenomena in living systems, and in particular the integrated use of cells, biomaterials and bioreactors in quantitative studies of cell function and tissue development. She is serving as the science lead of the design and testing of the cell culture system for the International Space Station. Her teaching responsibilities include Biomaterials and Tissue Engineering for Medical Devices (HST.588, course co-director), Quantitative Physiology of Cells and Tissues (6.021J, recitation instructor), and Biomaterials and Tissue Engineering (ChE 164 at Tufts University, lecturer).

FUNCTIONAL AND STRUCTURAL BIOMEDICAL IMAGING

Biomedical imaging is a relatively young field that enables physicians and scientists to "see" and better understand tissue and organ function. It provides investigators with the ability to visualize the structure of tissues and to capture their function on film. One type of biomedical imaging is magnetic resonance imaging (MRI), also known as nuclear magnetic resonance (NMR). Using electromagnetic fields and radio waves to read minute shifts in the magnetic alignment of protons in soft tissue such as the brain, it involves the collaboration of engineers, computer scientists, neuroscientists, and physicians. An important advance called functional MRI (fMRI) shows how living tissues are functioning in real time. For example, fMRI can make a 100-millisecond scan every few seconds to detect variations in regional blood flow within the brain to signal sight, hearing, thinking, or feeling. Combining many fMRI scans makes a real-time "movie" of functioning organs, a technique that has been especially useful in cognitive neuroscience and psychology.

Emery N. Brown devotes his research to statistical modeling of problems in neuroscience. Working jointly with colleagues in MIT's Brain and Cognitive Sciences Department, he is developing statistical signal processing techniques to analyze how neural systems encode information about relevant biological stimuli in their ensemble firing patterns. The techniques involve signal-processing methods based on point process filtering, and have been successfully applied to the study of how ensembles of pyramidal cells in the rat hippocampus encode the animal's representation of its spatial environment. In collaboration with members of the MGH NMR Center, Professor Brown is developing statistical methods to characterize the dynamic properties of functional magnetic resonance imaging (fMRI) signals. A forthcoming application of these methods will be to study anesthesia-induced loss of consciousness monitored with fMRI. In collaboration with colleagues at the Brigham and Women's Hospital, Professor Brown has developed statistical models to measure precisely the period of the human biological clock and to characterize the properties of circadian and neuroendocrine rhythms.

Martha L. Gray (HST '86), HST co-director, and collaborator Deborah Burstein (HST '86) use magnetic resonance to measure the composition and functional integrity of cartilage. Over the last century, little progress has been made in developing effective preventative and therapeutic strategies for arthritis, other than total joint replacement. among the challenges limiting progress has been the fact that there were no nondestructive means to visualize cartilage. Pioneering work by this team has yielded a clinically feasible method that is now employed in pilot studies. Work with Genzyme's Carticel™ product revealed an apparent improvement by 18 months after surgery. An evaluation of dysplastic hips revealed composition correlates with pain. These are examples of information that were previously unavailable. Clinicians and researchers have had to struggle to understand and treat diseases they could not see until significant cartilage destruction had occurred. This situation has the potential to improve dramatically with the method Professors Gray and Burstein have pioneered. In the past year, this method has been used to demonstrate nondestructively biochemical alterations in intact human cartilage. In addition, pilot clinical studies have begun to demonstrate subtle alterations in cartilage, which may be amenable to early pharmacologic intervention

Bruce R. Rosen (HST '84) is director of the NMR Center at the Massachusetts General Hospital and the new Athinoula A. Martinos Center for Functional and Structural Biomedical Imaging. He is well known for his contributions in the area of "functional" imaging—that is, magnetic resonance images of the brain in which areas having some functional activity (*e.g.*, visual cortex) are highlighted by receiving increased blood flow. The techniques he and his colleagues have developed are being used by hospitals throughout the world to evaluate patients with stroke, brain tumors, dementia, and other mental illness. Recent work has focused on the fusion of functional MRI data with information from other modalities, including very high temporal resolution signals using magnetoencephalography (MEG) and noninvasive optical imaging.

CLINICAL RESEARCH

One of the most visible arenas in which the bench-to-bedside transfer is a two-way bridge is therapeutics. Drugs and therapies not only treat disease by serving as probes, but they also can provide important insights into disease mechanisms and offer diagnostic opportunities. Many HST investigators are involved in clinical human studies at some point in their research. The opportunities available through MIT's Clinical Research Center, the Harvard Medical School teaching hospitals, and the Clinical Investigator Training Program, significantly enhance HST's research and educational programs, further enabling translational efforts from bench to bedside.

Robert H. Rubin, the Gordon and Marjorie Osborne Associate Professor of HST, has spent much of his clinical career studying and caring for transplant patients. Among his accomplishments are the development of new strategies for preventing the most important infections, particularly those due to viruses and fungi; the establishment of the link between certain viral infections and allograft injury and the development of certain malignancies; and the development of novel antimicrobial approaches that are effective not only in transplant patients, but also in such other immunocompromised patient populations as those with AIDS and cancer. In 1999, he was named to the chairmanship of the Infectious Disease Section of the International Transplantation Society and assumed the position of editor-in-chief of the journal, *Transplant Infectious Disease*. As director of HST's Center for Experimental Pharmacology and Therapeutics, Professor Rubin has pioneered the application of positron emission tomography, magnetic resonance imaging and spectroscopy, and other measurement technologies to the development of new drugs, including those designed for the transplant patient. In addition to his other responsibilities, Dr. Rubin is associate director of the Division of Infectious Diseases at the Brigham and Women's Hospital, charged with the responsibility of directing the clinical service and the clinical research program.

Professors Rubin and Alan C. Moses head the two-year Clinical Investigator Training Program, a joint effort of the Beth Israel-Deaconess Hospital, HST, and Pfizer, Inc. Trainees gain direct experience in clinical investigation and a strong foundation in the statistical and computational sciences, biomedical ethics, principles of clinical pharmacology, *in vitro* and *in vivo* measurement techniques, and aspects of the drug development process. After fulfillment of thesis requirements and successful performance on a qualifying exam, graduating trainees receive a MMSc degree in clinical investigation from HST.

Richard J. Wurtman, program director of MIT's Clinical Research Center, also conducts research into Alzheimer's disease. A generally held—if unproved—view of Alzheimer's is that dementia results from toxic effects of an abnormal protein, called amyloid, which is a polymer of small fragment (A-beta) of a protein (APP) produced normally in all cells. Hence, a major goal of researchers working to treat this disease is to find drugs that will decrease the formation of A-beta from APP and increase the production of APP's other major metabolite APPs ("soluble APP"). Professor Wurtman's laboratory has shown that both the synthesis of the APP and the proportions of it that are broken down to A-beta or soluble APP are under the control of the particular neurotransmitters and "second messengers" they generate. Thus, by using drugs that act on these receptors, it should be possible to block the formation of APP and all its metabolites, or promote the formation of soluble APP and suppress A-beta. This has been demonstrated in tissue culture and is in the process of being demonstrated in animal models of Alzheimer's. The next step, probably involving industry collaboration, involves devising a treatment to decrease the amount of amyloid in the Alzheimer's disease brain. This treatment may conceivably ameliorate the dementia of the disease.

BIOCOMPLEXITY

With medicine and biology undergoing a fundamental shift, new approaches to engineering, mathematics, and computer science will have to be developed concurrently with genetics and molecular cell biology. Existing

scientific disciplines will have to give way to increased communication and collaboration. Scientists typically found only in the engineering, physics, materials science, or mathematics departments will need to become immersed in the biomedical community. In turn, the biomedical community will need to transform itself into a nurturing environment for physical scientists. Through the success of the Human Genome Project, functional genomics, proteomics, and chemical microanalysis, an almost inconceivable amount of data is being generated that is related to individual molecular components comprising living cells and tissues. At the same time, the application of live cell imaging techniques, engineering approaches, and microfabrication are leading us to recognize the importance of spatial position, structure, and mechanics for cell regulation. The scientific challenge is to understand biological complexity: how life and cellular function emerge from the interactions of these different components. HST's work in this area is to develop entirely new analytical tools and computational models needed to describe the nonlinear emergent behavior of complex biological systems.

Joseph V. Bonventre (HST '76), HST co-director, studies the mechanisms of cellular and tissue injury and repair, particularly as related to ischemic injury to the kidney. Recent studies have focused on the role of inflammation and adhesion in the pathophysiology of acute renal failure. A novel adhesion molecule, KIM-1, has been cloned that is expressed at very high levels during the recovery phase of acute renal failure and in models of chronic renal disease as well as in a number of human kidney diseases including polycystic kidney disease. This molecule is shed from the cell membrane, and it appears in the urine of patients with kidney injury at an early stage of the disease process. Using PCR-based subtraction techniques and bioinformatics, a many additional genes whose regulation is altered during repair have been identified. Many of these represent potential targets for therapeutic interventions to prevent or treat kidney injury. Bone marrow derived stem cells have differentiated to epithelial cells replacing injured kidney cells. Approaches are being explored to facilitate this process and potentially regenerate the tubular epithelium and restore function to a failing kidney. Transcription factors are important determinants of the cellular repair processes after an ischemic insult to the kidney. A novel kidney-specific zinc finger transcriptional repressor, Kid-1, whose expression is regulated in renal ontogeny and by ischemia/reperfusion was cloned and characterized. The Kruppel Associated Box-A (KRAB-A) motif of this and other zinc finger proteins was identified as a common repressor motif. A transcriptional repressor, KRIP-1, that interacts with KRAB-A has been cloned. A new family of proteins that associates with KRIP-1 (Trip-Br family) have been characterized which interact with E2F/DP1, two critical proteins for cell cycle regulation. A second major focus of the lab is phospholipase A2 (PLA2) and the role of this family of enzymes on acute tissue injury, apoptosis, signal transduction and nuclear events including transcription. Using the yeast two-hybrid system, a nuclear protein that interacts with the cytosolic 85 kDa cPLA2 has been identified. A cPLA2 knock-out mouse has been created to study the function of PLA2s in signal transduction and renal, respiratory, gastrointestinal and neurological disease. Gene therapy approaches with adenovirus are being used.

George Q. Daley (HST '91) is investigating the signaling pathways that allow the BCR/ABL oncoprotein to induce leukemia. His laboratory has demonstrated that a novel class of pharmaceutical agents called farnesyl transferase inhibitors have potent activity against BCR/ABL-induced leukemia and active clinical testing of these agents are underway. His lab has also demonstrated that hematopoietic stem cells develop from pluripotent embryonic stem (ES) cells that are differentiated in culture, an important step towards using ES cells for cellular therapies.

Lee Gehrke, Professor of Health Sciences and Technology, studies the replication and assembly of viruses that use RNA as their genetic material. Important biochemical processes that allow viruses to replicate depend on docking interactions between RNA and protein molecules. Professor Gehrke's laboratory is focused on identifying these docking signals, an effort that will facilitate therapeutic approaches for blocking virus replication and assembly. The research has led to the molecular identification of amino acids and nucleotide sequences that are crucial for forming the RNA-protein interactions; moreover, the work also suggests the shape or conformation of the molecules changes upon binding. Another aspect of his work is learning how viruses are able to gain an advantage over the infected host cell in expressing their own genetic information. Nucleotide signals in a viral messenger RNA have been identified that give the virus a competitive advantage, and the lab is now working to elucidate the detailed mechanism.

Richard N. Mitchell, HST's associate director, researches the mechanisms underlying acute and chronic rejection in solid organ allografts, with specific emphasis on heart transplants. His work runs the gamut from mouse transplant models to human clinical transplantation, and is focused on understanding the specific immunologic pathways that drive rejection and ultimately graft failure. His lab is particularly interested in the mechanisms that induce the process of "chronic rejection" whereby the vessels in transplanted hearts become progressively more occluded until the grafts get starved for blood and die. The research may have much broader applicability, since the inflammatory mediators that drive the occlusive process in transplanted hearts may also be involved in mediating the vascular wall thickening that characterizes more "typical" atherosclerosis. Professor Mitchell's laboratory uses several genetically engineered mice (so-called "knock-out" mice), which are either deficient in cell surface molecules that promote the cellular cross-talk necessary to promote rejection, or which lack particular "cytokine" mediators or their receptors. In collaboration with other members of the HST community, such as Professors Elazer Edelman and Andrew Lichtman, Professor Mitchell has been evaluating new interventions to prevent the chronic vascular pathology. His group has also developed collaborations with several pharmaceutical firms such as Schering-Plough, Bristol Myers-Squibb, and Novartis.

Jane-Jane Chen, HST Principal Research Scientist, studies the regulation of hemoglobin synthesis and erythropoiesis by the heme-regulated eIF-2 alpha kinase (HRI). Her group has knockout the HRI gene in mice, and established that HRI, which is expressed predominantly in erythroid cells, regulates the synthesis of both a and b globins in red blood cell precursors by inhibiting the general translation initiation factor eIF2. This inhibition occurs when the intracellular concentration of heme declines, thereby preventing the precipitation of excess globin polypeptides. In iron deficient HRI-/- mice, globins devoid of heme aggregated within erythrocyte and its precursors, resulting in a hyperchromic, normocytic anemia with decreased red blood cell count, compensatory erythroid hyperplasia and accelerated apoptosis in the bone marrow and spleen. Thus, HRI is a physiological regulator of gene expression and cell survival in the erythroid lineage. These data have significance for further understanding the physiological role of HRI in the production of not only hemoglobin, but also red blood cells upon stress.

INFORMATICS AND COMPUTATIONAL BIOMEDICAL SCIENCES

Knowledge discovery and its dissemination in health care have been deeply influenced by recent advances in computer science and engineering. Medical and biological informatics is the use of computer technology to extract, transport, and manage information from medical and biological data, and to model and support human decision-making in clinical and biological domains. The field is a scientific and engineering activity that is inherently multidisciplinary. Research challenges include: deducing and mapping genomic structure, predicting structure and function of proteins, representing medical knowledge for modeling diagnostic and prognostic decision-making processes, extracting new information from large clinical and biological data sets, building comprehensive electronic medical records (EMR) and clinical information systems, interfacing monitoring devices and the EMR, assuring privacy and confidentiality in medical transactions, analyzing and manipulating images, recognizing patterns of disease progression, analyzing costs and benefits related to medical use of information technology, computer-aided instruction, and utilizing the Internet for providing education and health care services.

Robert A. Greenes, director of HST's Medical Informatics Training Program, established the Decision Systems Group (DSG) at Brigham and Women's Hospital in 1978 to pursue the application of information technology in physician education and decision making. Professor Greenes has a 37-year history of work in the area of medical informatics. The DSG lab, which includes physicians, computer scientists, database experts, and specialists in graphics and educational technology, has a major focus on developing means to enhance decision support and education in medicine and for integrating these capabilities into clinical practice. Primary technologies involve knowledge representation, machine learning, decision science, and information retrieval. The DSG is also is working in the area of bioinformatics, particularly in the development and application of machine learning, classification, and prediction methods, for analysis of DNA microarray data, and of flow cytometry data characterizing cellular proteins.

Isaac S. Kohane, director of HST's Program in Bioinformatics and Functional Genomics, is involved in leading multiple collaborators in bioinformatics as well as tumorigenesis, neurodevelopment, neuroendocrinology, and transplantation biology. He also created the World Wide Web Electronic Medical Record System (W3-EMRS), which has served as the foundation for several multi-institutional implementations and collaborations.

Lucila Ohno-Machado investigates machine-learning techniques to extract information from clinical databases, especially in the form of predictive models for prognosis. She has used special methods to predict survival for patients with AIDS, to assess the probability of myocardial infarction in certain populations, to predict ambulation for patients with specific kinds of spinal cord injuries, and to predict outcomes in other clinical domains. Her research is focused on the development and evaluation of models involving binary outcomes. She is interested in deploying practical models for direct use by patients, physicians, and health care managers, so that they can make decisions that are more informed. An example in this area is a project that uses artificial intelligence techniques for dealing with uncertainty to select suitable clinical trials for patients with certain types of breast cancer. Other areas of interest include decision support to help patients recognize early symptoms of a heart attack, patient education, and remote teaching using information technology.

SPEECH AND HEARING SCIENCES

In a world with increasingly complex societal interaction, there is an imperative need to understand how humans communicate, and what can be done to assist those with impaired abilities to produce speech or to perceive auditory signals. HST's Speech and Hearing Sciences research focuses on the biological and physical mechanisms underlying human communication by spoken language. The processes addressed by these sciences include the physical acoustics of sound and the perceptual and neurophysiological bases of hearing, as well as the cognitive and linguistic levels of processing by talkers and listeners. This research and its application to human needs is inherently an interdisciplinary activity.

Understanding the process of receiving and translating speech sounds has been the focus of several HST researchers, including Dennis M. Freeman. Via a bundle of microscopic hairs, sensory cells in the inner-ear sense sound-induced motions of inner-ear structures, which trigger neural messages that relay information about sound to the brain. Professor Freeman and his colleagues have measured the motions of a lizard's inner-ear sensory cells in response to sound stimulation. They have also measured mechanical properties of the tectorial membrane, an essential tissue that mechanically stimulates hair cells. In this work, they have obtained the first quantitative measurements of the bulk modulus, fixed charge concentration, and point impedance of the tectorial membrane. In their related

microelectromechanical systems (MEMS) work, his group developed a Mirau interferometric imaging system to characterize MEMS motions and used it to measure dynamic profiles of flexible MEMS (optical gratings). This dynamic profilometer for MEMS is likely to have important applications in many MEMS labs. In the area of synthetic aperture optics, in addition to building a 50-beam synthetic aperture light projector using 488 nm light, his group also built a surface-acoustic-wave (SAW) light modulator and used it to break a single incident beam at 193 nm into hundreds of output beams with controlled amplitudes and phases. The SAW optical modulator is likely to have wide application as a general light modulator.

M. Charles Liberman, director of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary, studies the neurobiology of hearing and hearing loss in animals and humans. His work on normal hearing investigates the structure and function of the four major classes of afferent and efferent neurons connecting the inner ear with the brain. Notable recent progress includes the discoveries that sound-evoked activation of one of the efferent feedback pathways protects the inner ear from permanent acoustic injury and that inter-subject variation in the strength of this feedback reflex can predict susceptibility to hearing damage in noisy environments. His work on hearing loss is currently focusing on prevention of presbycusis, or age-related hearing loss. His laboratory has recently demonstrated a genetic manipulation in mice, which dramatically minimizes age-related hearing loss as well as the age-related loss of sensory cells. The molecular mechanisms underlying this protective effect are now under investigation.

John J. Rosowski is co-director of the Wallace Middle-Ear Research Unit of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary. He and his colleagues strive to understand how the structures of the external and middle ear affect what we hear by measuring the function and structure in normal and pathological ears. On the order of one percent of the human population suffers from some form of chronic middle-ear disease, and thousands of surgeries are performed annually at the Massachusetts Eye and Ear Infirmary alone to control these diseases and restore hearing. The Wallace unit is investigating the clinical utility of laser-Doppler measurements of sound-induced middle-ear velocity in patients and human subjects in order to diagnose middle-ear disease and evaluate post-surgical results. Preliminary results indicate certain hard-to-diagnose ossicular abnormalities can be differentiated by vibrometry, and that the reasons for a large percentage of middle-ear surgical failures can be determined by this procedure.

Bertrand Delgutte and his colleagues seek to understand the neural mechanisms for perception of sounds. In the past year, Martin McKinney (a graduate student in HST's Speech and Hearing Sciences program) and Dr. Delgutte focused on how auditory neurons respond to musical sounds. The universality of many aspects of music, such as octave relationships and the use of dissonance and consonance to create harmonic tension and resolution, suggests that they may have fundamental neurophysiological bases. Thus, music provides a natural set of stimuli and associated percepts with which the auditory system can be studied. They found that most neurons in the auditory midbrain respond preferentially to pairs of tones forming dissonant musical intervals (such as a minor second) than to pairs of tones forming consonant intervals such as a fifth or a fourth. Their findings show that percepts generally considered cognitive, such as the dissonance of musical intervals, have direct correlates in the responses of auditory neurons. In general, a better understanding of how the auditory system processes musical sounds may help design hearing aids and cochlear implants that would improve the quality of life of the hearing-impaired by providing them with a more enjoyable musical experience.

CARDIOPULMONOLOGY

HST's cardiopulmonary research is dedicated to developing innovative diagnostic and therapeutic technologies and medications that will have an impact on clinical care within a ten-year period. Traditionally, academic institutions have focused on long-term basic research, whereas the research efforts of pharmaceutical companies, as well device and equipment manufacturers, have focused on development. HST's cardiopulmonary investigations focus on novel ideas that bridge this gap between basic research and applied development. In order to achieve translational research and to train new investigators in this field, HST builds on its strong ties to academic and clinical laboratories, including the Boston Heart Foundation, and develops new ties with industry. In cooperation with these partners, HST's cardiopulmonary effort will be able to provide products designed for a patient's specific phenotype when developing new technologies and drugs.

The laboratory of Richard J. Cohen (HST '76), Whitaker Professor of Biomedical Engineering, is involved in the development of cardiovascular diagnostic and therapeutic technologies. One of the technologies developed in his laboratory is the noninvasive measurement of microvolt level fluctuations in electrocardiographic signals to identify individuals at risk for sudden cardiac death from heart rhythm disturbances. This technology, called the measurement of microvolt T-wave alternans, has been commercialized by a company that Dr. Cohen helped found--Cambridge Heart, Inc. This past year, the technology has been successfully tested in a wide range of international clinical trials and is currently being introduced into widespread clinical practice. Under sponsorship of the National Space Biomedical Research Institute, Dr. Cohen is using this technology to determine whether long duration space flight increases the risk of life threatening heart rhythm disturbances. Dr. Cohen's laboratory was also involved in demonstrating the effectiveness of a new pharmacologic countermeasure to another adverse effect of space flight on the cardiovascular system. After long duration space flight, astronauts develop orthostatic hypotension; meaning that their blood pressure drops when they attempt to sit or stand. This effect may be so severe as to cause syncope or fainting. Dr. Cohen's laboratory collaborated in studies demonstrating that a single oral dose of the sympathetic

alpha-agonist midodrine taken at the end of simulated space flight is effective in markedly reducing the development of orthostatic hypotension. Plans to test this drug in astronauts are in progress.

Robert S. Lees, Professor of Health Sciences and Technology, and his colleagues have devised a noninvasive method for assessing atherosclerosis in the abdominal aorta, the site where the disease begins and where it is sometimes found even in children. They are using magnetic resonance imaging, with quantitative analysis, of the images. They plan to use this technique—along with the established method of quantitative carotid ultrasound—to determine the effects on the progression (or regression) of atherosclerosis with interventions such as the new cholesterol-lowering margarines (whose action may be slower, but more tolerable than that of cholesterol-lowering drugs). The new technique is one of several methods they have developed and brought into the clinic during their thirty years of cardiovascular imaging and diagnostic research at MIT.

Daniel C. Shannon is a founder of the field of pediatric intensive care and pulmonology. For more than two decades, he has been furthering his breakthrough studies into the rare condition of congenital central hypoventilation syndrome (CCHS). Dr. Shannon and his colleagues have added incrementally to their framework of knowledge about the problem, using whatever new tool they could find to test specific hypotheses. One of his associates in these studies recently received an award from the NIH for discovering the first gene that controls respiration. Still, the clinical problems—like a child's failure to breathe adequately when asleep—continue to stump clinicians and researchers alike. His latest research reflects the use of technology to serve patients better.

FUTURE PLANS

HST was awarded an NIH grant to fund a new predoctoral training program in life sciences and genomics disciplines. The program's new doctoral track will train a new generation of quantitative scientists who are expert in the biology, engineering, and information science of genomics. The program will be launched in spring 2002 with the admission of three students. Seven students will be admitted annually thereafter. It will function under the auspices of HST's Medical Engineering and Medical Physics program, sharing structural elements such as: simultaneous admission to HST and to a collaborating MIT department; participation in preclinical subjects at HMS; the opportunity to participate in clinical subjects; a seminar series; access to laboratories at MIT, Harvard, the Harvard teaching hospitals; and a community of student peers with shared interests in the intersection of the biological and computational-engineering sciences.

Medical innovations gleaned through laboratory research and clinical care can only have societal benefit when translated into commercial products and services. Yet, leaders in industry rarely bring together the three disciplines of medicine, science-engineering, and business. HST is working with MIT's Sloan School of Management to develop a program that will prepare an extraordinary group of students to lead the development of new technologies from concept through product development to clinical adoption. The two-year program is being designed for students with both business experience and a strong grounding in quantitative science. The curriculum will leverage the unique strength of both HST and Sloan. Students will take preclinical and engineering courses alongside HST M.D. and Ph.D. students, and Sloan business courses with other MOT and MBA students. Courses designed specifically for this program by HST and Sloan faculty will address the particular challenges and issues involved with the commercialization of health care products. HST and Sloan plan to offer this program beginning in the fall of 2002.

HST and MIT's Division of Bioengineering and Environmental Health (BEH) are working to broaden the program leading to a Master of Engineering in Biomedical Engineering (MEBE). Designed to further the education of MIT undergraduates at the interface of engineering and biology or medicine, the MEBE program was created in response to the growing interest in the fields of bioengineering and medical engineering. Through the MEBE program, HST and BEH seek to educate and prepare students for leadership positions in the medical products, pharmaceutical, and biotech industries. The current bioengineering track (BE), which emphasizes the unification of engineering and biology, was introduced in September 2000, under the auspices of BEH. A new medical engineering track (ME), which will emphasize applications of engineering in systems physiology, biomedicine, and health sciences will be launched in fall 2002 under the auspices of HST.

The MGH/MIT/HMS Athinoula A. Martinos Center for Functional and Structural Biomedical Imaging is a paradigm for this growth. A survey course of functional imaging techniques, offered in the fall 2001, will be open to students in HST, other MIT and Harvard departments, and students of investigators conducting research at the center. In addition to its powerful magnetic resonance facilities, the installation of a 306-channel magneto-encephalography (MEG) system is underway. Plans are underway to bring position emission tomography (PET) imaging capabilities to the center.

HST's charter membership in the National Space Biomedical Research Institute (NSBRI) has brought considerable money to MIT and has served as a focus for research in manned space flight. The membership of the NSBRI has grown beyond the initial charter group of HST, Johns Hopkins University, Baylor College of Medicine, Rice University, Morehouse School of Medicine, and Texas A&M University to include the University of Washington, University of Arkansas for Medical Sciences, Brookhaven National Laboratory, University of Pennsylvania Health System, and the Mount Sinai School of Medicine. The number of research teams has also been expanded from eight

to twelve. HST faculty represents a significant number of investigators within these programs. Large growth in funding is projected for NSBRI programs.

More information about the Harvard-MIT Division of Health Sciences and Technology can be found online at http://harvard-mit-hst.edu/.

Martha L. Gray

CENTER FOR BIOMEDICAL ENGINEERING

The mission of the Center for Biomedical Engineering (CBE) is to combine engineering with molecular and cellular biology to develop new approaches to biomedical technology and to foster research in the rapidly growing discipline of Biological Engineering. CBE now has almost 50 faculty members (from departments in the MIT Schools of Engineering and Science, as well as the Whitehead Institute, Harvard and Boston University Medical Schools, and the Harvard-MIT Division of Health Sciences and Technology) carrying out interdisciplinary, multi-investigator research programs within the center. This faculty research provides a training environment for new generations of graduate and undergraduate students in bioengineering, at the interface between engineering and biology.

FACILITIES

To accomplish this mission, CBE maintains a complex of state-of-the-art Core Facility, including Multi-Photon Imaging and Atomic Force Microscopy and a new Cryofixation, Freeze-Fracture/Deep Etch facility comprising a Leica EM-CPC Plunge Slam Freezer and a Cressington CFE-60 Freeze Fracture System. This facility allows users to bring tissue specimens, cell cultures, cell-seeded scaffolds and take away a dimensionally stable platinum/carbon replica of the cryopreserved ultrastructure for electron microscopy. Additional core facilities focus on molecular modeling and engineering, biomolecular interactions and cell responses, and cell-ligand interactions.

RESEARCH PROGRAMS AND DISCOVERIES

An emerging thrust area within CBE is the field of mechanobiology, focusing on the combined role of physical and biological signals in the regulation of cellular behavior. CBE faculty researchers in the musculoskeletal and cardiovascular systems have greatly expanded their programs in this area. Major initiatives this past year include the funding of a Program Project Grant by NIH on "Mechanotransduction In Cardiovascular Cells." This is a multi-investigator collaboration involving CBE faculty members from the Schools of Engineering and Science, and the Brigham and Women's Hospital, Harvard Medical School. The central theme of this program is that mechanical forces are fundamental regulators of molecular events in the cardiovascular system because the cell functions as an integrator of mechanical and biochemical signals to provide the overall molecular response. The goal of this program is to close the gap between bioengineering and cell biology, by interfacing fundamental studies of mechanotransduction with studies of highly differentiated cellular responses that are directly relevant to cardiovascular diseases. The specific faculty-lead research projects focus on subcellular mechanotransduction in vascular smooth muscle cells and endothelial cells, quantitative aspects of integrin/ligand interactions in mechanotransduction, and the role of cardiac cycle phase in cellular mechanotransduction.

Among the many outstanding research accomplishments by CBE faculty this past year, new discoveries have revealed exciting applications for novel, self-assembling peptide hydrogel scaffolds in tissue engineering. This emerging technology has resulted in a broad spectrum of biocompatible materials through molecular engineering, which have been used to encapsulate cells such as neurons, chondrocytes, hepatocytes, and cardiomyocytes. Cartilage cells were found to generate new cartilage-like tissue and simultaneously proliferate in these peptide bio-scaffolds, opening possibilities for new approaches to cartilage repair. Neural cells were observed to undergo differentiation within the peptide hydrogels. Further discoveries were made in understanding the mechanisms by which these peptides form nanotubes, the building blocks of porous networks for cell implantation. The ongoing DARPA-funded CBE Program in Vascular Tissue Sensors for Generic Toxin and Pathogen Detection has also been a leader in the interface of cell and molecular sensing. This program involves 13 co-PIs, and has produced exciting new advances which have been leveraged, in part, by CBE's Multi-Photon Microscopy facility.

ENGINEERING/BIOLOGY SEED GRANT PROGRAM AND THE CBE INDUSTRIAL ADVISORY BOARD

CBE's novel Engineering/Biology Seed Grant Program continues to act as a catalyst for multidisciplinary collaborations funded by members of CBE's Industrial Advisory Board. CBE's next Industrial Advisory Board meeting will occur this coming spring 2002, at which students and faculty will present oral and poster presentations summarizing their latest research initiated under the auspices of the Seed Grant Program. New discoveries from current Seed Grants on chondrocyte migration for cartilage wound repair and as well as gene delivery in collagen-glycosaminoglycan matrices for articular cartilage regeneration show promise in musculoskeletal tissue engineering.

More information about this center can be found online at http://web.mit.edu/cbe/www/.

Alan J. Grodzinsky

CENTER FOR ENVIRONMENTAL INITIATIVES

Established in 1997, The Center for Environmental Initiatives (CEI) supports, coordinates and conducts research and education on environmental and sustainability issues that impact development and welfare worldwide. The work of the center is aimed at providing knowledge, demonstration and collaboration in the development of scientifically and economically sound strategies for industry and government to respond to global environmental challenges. As a neutral broker, CEI aims to foster constructive relationships between industry, governments, academia and the public to seek solutions to environment and sustainability issues. Through interactions in our research and outreach initiatives, CEI also strives to strengthen industry's role as an agent of change for the protection of the environment and sustainability. CEI works to build better understanding of the many issues between and among developed and developing nations that arise in the context of meeting global environmental challenges (including questions of eco-efficiency, equity, futurity and security). A central theme running through all of CEI's initiatives is the role of science and technology in shaping better environmental policy at all levels in both the public and private sectors. The education program of CEI is committed to educating the next generation of environmental and sustainability leaders worldwide via joint projects, distance education and special educational programs.

Professor David H. Marks of Engineering Systems and Civil and Environmental Engineering is Director. Dr. Joanne Kauffman, Principal Research Scientist and Lecturer in Political Science, is Deputy Director. The Executive Committee of the MIT Council on the Environment serves as the Steering Committee for the Center.

MAJOR ACCOMPLISHMENTS

Working with other labs and centers throughout the Institute, CEI has successfully put in place an institutional architecture needed to advance MIT's commitment to greater emphasis on environment and sustainability. Four major programs are in place to facilitate multi-disciplinary research and education initiatives that bring together faculty and students from across the Institute—not just the relatively small percentage who identify themselves as environmental professionals. In 2000–2001, CEI attracted new faculty and additional resources to support multi-disciplinary research programs, expanded its educational initiatives both locally and internationally, carried out a major study on the future challenges in meeting growing global transportation demands, with the World Business Council on Sustainable Development, and strengthened its outreach and education activities and public communications. The research programs of the CEI involve over 50 MIT faculty and over 100 students annually.

With respect to building synergy across the Institute, the CEI provides co-leadership for the Council on the Environment and continued its weekly seminar series on global environment and sustainability issues. The seminar series includes presentations of work in progress on environmental challenges as well as timely issues by invited guests.

Two major events of the past year are illustrative of the progress that the CEI has made toward achieving its goals for expanded outreach and communication. First, the CEI coordinated MIT's participation in the January 2001 Annual Meeting of the Alliance for Global Sustainability, and helped to develop the meeting program with a focus on the applications of technology to meet the challenges of sustainable development. The meeting attracted over 350 scholars and representatives from industry, government and NGOs around the world. The proceedings of the meeting will serve as a resource for our own affiliates as well as other academics who are concerned with the application of scholarly research to sustainable development. CEI also led the development of the new Web site for the Alliance for Global Sustainability, a global resource for information on methodologies and frameworks for decision making that will contribute to solving sustainability issues worldwide.

COMPONENT PROGRAMS

In year 2000–2001 CEI carried out its mission through four component programs. Three of the programs support and coordinate research for the environment and sustainability. The fourth is responsible for oversight of the education initiatives of the center including two Fellowship programs and MIT's participation in international education activities of the Alliance for Global Sustainability. CEI's programs in 2000–2001 were: the Alliance for Global Sustainability (AGS, international focus), the MIT/AGS Consortium on Environmental Challenges (focus on science and technology in environmental decision making), the Energy Choices Venture Fund (focus on robust technology options for a greenhouse gas constrained world, managed with the MIT Energy Lab), and the Program on Environmental Education and Research (educational component). The CEI also plays a major role in support of the program on Integrated Assessment in dealing with air pollution in the world's mega-cities: the Mexico City Case Study, which is led by Professor Mario Molina and Dr. Luisa Molina.

CEI's four major initiatives provide coherence to a strong research portfolio of projects. In 2000–2001 The CEI supported 58 graduate student RA's in research projects, and 17 graduate students through fellowships. The research

projects supported through the CEI are not only leading to important results and the development of methodologies for assessment of options for technologies and policies that will support sustainable development in industrialized and developing countries alike—they are also providing tremendous hands-on experience for a growing number of our own students and leading to the development of a world-wide network of leaders in policy and technology who understand the multidimensional aspects of these problems and can identify the resources needed to deal with them.

Alliance for Global Sustainability

AGS-supported research brings together scholars from the three founding partner universities (MIT, the Swiss Federal Institutes of Technology, and the University of Tokyo) with partners from industry, NGOs, government and other leading academic institutions to address complex environmental problems that transcend geographical and disciplinary boundaries. In 2001, Chalmers University of Technology of Sweden became the AGS fourth partner. At the annual meeting of the Alliance for Global Sustainability at Lausanne Switzerland in January, the AGS Governing Board awarded funding for 15 new projects over the next two years. This new funding brings the number of international multidisciplinary research projects supported by the AGS to over 60. These projects fall within three major focus areas: water, energy and mobility. In addition, some of the projects address crosscutting issues such as urban systems, cleaner technologies, policies and institutions, and communications and outreach for sustainable development.

AGS project leaders have raised more than $20 million to supplement these projects and related sustainability research at the partner universities.

MIT/AGS Consortium on Environmental Challenges

Created in 1997, the Consortium on Environmental Challenges (CEC) in 2000–2001 entered Phase II of the research projects it initiated in 1998 with the advice of its Advisory Committee. This committee endorsed the merger of the Consortium with the AGS. This merger provides greater international reach and synergy in the programs initiated at MIT as well as enhanced visibility through the AGS International education and outreach programs. The MIT/AGS (formerly the CEC) focuses on the role of scientific and technologic knowledge in environmental decision-making and seeks to provide recommendations for improving the scientific foundation for policies and decisions that impact the global environment. The MIT Management Team for the CEC includes Professors David Marks, Mario Molina and Kenneth Oye, and Dr. Joanne Kauffman. CEC goals are to:

- Assess global environmental challenges and their impact on ecosystems, economic development and health.
- Identify and contribute to the knowledge needed to meet those challenges; and
- Improve policy making through use of unbiased knowledge—scientific, technological and socio-economic.

MIT/AGS scholars from across the Institute are assessing the state of knowledge needed to effectively meet global environmental challenges by focusing on specific issue areas.

Current linkages focus on energy choices for the future; the automobile and sustainability with an emphasis on options for future road transportation; water for a sustainable future; air quality in the world's burgeoning mega-cities (case study on Mexico City); and ways to improve decision-making under conditions of uncertainty. Working papers available from the program include analyses of case studies on the use of science in environmental decision-making, constraints on the use of scientific and technical knowledge in environmental decision-making, and papers on each of the specific project areas.

Through this initiative, researchers are looking to understand how to increase the role scientific evidence and technological knowledge play or can play in meeting the challenges posed by environmental risks to economic development and social welfare.

The Mexico City Case Study Project is an important example of how the best science and technology can be applied to solution of contemporary problems. The program, which is supported by the Mexican Government as well as through the CEI and other sources, is working with public officials and stakeholders on ways to improve air quality in Mexico City and contribute to the solution of related regional and global air quality problems. The project includes identification of sources and effects of air pollution in Mexico City through high quality science carried out at MIT and with its partners in Mexico and elsewhere. More information can be found at the project's web site: http://eaps.mit.edu/megacities/.

Major accomplishments pf the MIT/AGS consortium in 2000–2001include major workshops and executive education training in Mexico City, strategic faculty workshops on major issues including a national workshop on Future Technologies for Road Transportation, led by Professor John Heywood, Dr. Malcolm Weiss, and Dr. Elisabeth Drake. This project is also a component of the Venture Fund for Energy Choices (below). A number of theses supervised by the Center for International Studies under the auspices of the MIT/AGS program have been

completed that consider new approaches to environmental decision making and policy making and the groundwork carried out in the consortium and with CIS researchers has led to planning for a new MIT program on Science, Technology, and Environmental Policy.

The MIT Consortium on Environmental Challenges was created in October 1997, when MIT and Ford Motor Company announced a collaboration focusing on education and research. As a component of this partnership, Ford pledged $5 million over five years to initiate and support the environmental challenges consortium. The program now includes sponsors from Norsk-Hydro, Exxon-Mobil, ABB, DuPont and 3-M.

Energy Venture Fund: Energy Choices

A generous gift of $1,350,000 over two years from the V. Kann Rasmussen Foundation allowed MIT to launch broad research initiatives in 1997 focusing on innovative energy solutions. In 2000, the foundation extended its support by $1 million over a two-year period. These funds are used in conjunction with funds raised from corporate and other sponsors to pursue important research in strategic areas of opportunity.

The Steering Committee for the Venture Fund developed the following strategic elements to be used in choosing investments:

- Identification of high potential/high risk areas where significant impacts might be likely, but where conventional funding sources are unlikely to invest in the near term
- Ability to leverage existing expertise and research within MIT and its research networks
- Linkage to relevant non-MIT programs
- Synergy with MIT educational goals
- Potential for public outreach, visibility, and leadership

In the past year, The Venture Fund Steering Committee continued to invest in projects that support China's efforts to improve energy efficiency in buildings, and in projects to improve the safety and reliability of the expanding nuclear industry in china and elsewhere. The focus of the sustainable buildings project is on residential buildings in large Chinese cities beginning with Beijing and Shanghai. The project has emphasized the use of materials and building styles appropriate and available in the local area. In 2001, the research entered an implementation and outreach phase with workshops and demonstrations projects organized for stakeholders in China.

With respect to its focus on carbon management and CO2 mitigation, CEI supported an international workshop on safety and reliability of nuclear energy organized by the Center on Advanced Nuclear Energy Systems (CANES) led by Professor Mujid Kazimi. An additional project in 2000–2001 supported research on ways to mitigate carbon emissions including through sequestration techniques. Mr. Howard Herzog of the MIT Energy Lab leads the project.

Education and Curriculum Initiatives

CEI carries out its educational initiatives through the Program on Environmental Education and Research (PEER) this program is directed by Professor Jeffrey Steinfeld. The objectives of PEER are to encourage multi-disciplinary educational initiatives, to strengthen existing efforts, to promote communication among faculty, students, and staff with interests in these topics, and to integrate the findings of leading-edge research into the education of every student at MIT.

The mission of the Environmental Education Program is twofold. First, it seeks to expand the environmental content in the academic curriculum, and to raise environmental awareness among MIT's population. Second, the program seeks to facilitate the development of education, training and outreach efforts among the environmental research programs. The program is dedicated to the development of increased awareness of the relationship between the academic programs here at MIT, and the world around us.

Towards this end, the program acts as a resource for faculty staff and students who are interested in developing new content for their courses and performing environmentally related research. The program also helps facilitate the development of education, training and outreach efforts.

Examples of education programs currently in progress are:

- Case study development—This effort uses ongoing environmental research efforts at MIT to provide content for the development of curricular materials. These materials will be designed to be useful in a variety of different academic disciplines, at a variety of different academic levels.
- International education programs—The MIT education initiative co-directs the international Youth Environmental Summit of the Alliance for Global Sustainability. A two-week intensive course for students around the world was piloted in summer 2000. 32 students from 11 countries participated in the highly successful event in Braunwald Switzerland.

- Capacity building—Organized mid-career training for decision-makers in Mexico for Mexico City Project on the environment
- Fellowship Programs—The environmental education program also manages two successful fellowship programs for scholars in sustainability at MIT. The Knut and Alice Wallenberg Foundation fellowship program at MIT provides two-year support for selected postdoctoral students from Sweden to work in research groups at MIT focusing on environmental and sustainability issues. The Martin Family Graduate Fellowship Program in Sustainability was established to honor graduate students across the institute working in issues of environment and sustainability. The students are nominated by the faculty and participate in numerous environmental activities including the AGS Annual Meeting and in the weekly seminar programs. In addition, this year, CEI organized a retreat for the Martin and Wallenberg Fellows to focus on sustainability issues. A generous gift from the Martin Family Foundation through Lee '42 and Geraldine Martin has led to funding for eight–ten of the Martin Fellows/year.

The CEI concluded its year with plans to consolidate its activities with the MIT Energy Lab and to move its operations to Building E40 where most of the multi-disciplinary programs in environment will be located to ensure better coordination and enhanced synergy among them.

More information about the Center for Environmental Initiatives can be found online at http://cei.mit.edu/.

David H. Marks

CENTER FOR MATERIALS SCIENCE AND ENGINEERING

The Center for Materials Science and Engineering (CMSE), an interdepartmental center at MIT, continues to be an innovative and dynamic program in interdisciplinary materials research and education. Funded since 1994, CMSE is the largest of a nation-wide network of twenty-eight Materials Research Science and Engineering Centers (MRSEC) sponsored by the National Science Foundation (NSF).

MIT has an extraordinarily strong and broad effort in materials science and engineering involving over 120 faculty members in 12 departments in the schools of science and engineering. Much of the research addresses intermediate-term engineering problems, often with the participation and support of industry. However, the longer-range problems, especially those that require a multi-investigator approach, are often overlooked. In this environment CMSE has a special mission: to foster collaborative interdisciplinary research and education in the fundamental science of materials and in the engineering of materials for long-range applications that will meet the needs of society. To accomplish this, CMSE promotes collaboration among MIT faculty and between MIT researchers and the researchers of other universities, industry, and government and nonprofit laboratories.

Collaborative research is encouraged through several mechanisms: interdisciplinary research groups (IRGs), shared experimental facilities (SEFs) and outreach programs. The IRGs, described below, are composed of MIT faculty who, with their students and postdoctoral associates, investigate fundamental scientific questions and pathways to reach significant technological goals that can only be properly explored in a collaborative, multidisciplinary mode. These problems are too large in scope to be addressed by individual faculty members and their students. Collaboration is essential for materials-related science and engineering, even for individual investigators, because such research requires very sophisticated equipment. CMSE provides a mechanism for the purchase and supervision of such equipment in its SEFs. The equipment is made available to the members of the IRGs, individual MIT investigators, and researchers from other university, industrial, government, and nonprofit laboratories.

CMSE also provides seed and initiative funds. While preference is given to young faculty, CMSE uses seed and initiative funds to support research that has the potential of redefining the direction of an existing IRG or leading to the creation of a completely new IRG. Seed funding provides CMSE with the flexibility necessary to initiate high-risk research.

ADMINISTRATION

This has been another year of change for the center. In January, Michael F. Rubner became the director of the center, replacing Bob Silbey who became the new Dean of Science. Professor Rubnere also has kept his role as safety officer for Building 13. Ron Hasseltine has moved on to become the Assistant Dean, School of Science. His position as Assistant Director was filled in May by Gayle Wolf. Karen Fosher, fiscal officer, has moved on and was replaced by Michael Enos. Other administrative staff changes include the addition of Jessica Landry and Generoso Fierro who are providing superior administrative support to the Center. We've also added a full time facilities coordinator to the center. Edward Kruzel has been hired to direct the extensive renovation of Building 13 as well as the daily ongoing facility needs of the building. Finally, we are in the process of preparing for the submission of a competing renewal of our MRSEC grant which funds this center.

INTERDISCIPLINARY RESEARCH GROUPS

Microphotonic Materials and Structures

In the past 50 years, semiconductor technology has come to play a vital role in almost every aspect of our daily lives. In the next 50 years, our technology may be just as thoroughly revolutionized by the replacement of electrons with photons (i.e. light) as the carrier of information. Photons have several advantages over electrons, including greater speed, greater information carrying ability, and greater energy efficiency. The key to achieving this advance, and the principal goal of this IRG, is the development of an exciting new class of materials, called photonic crystals, which will allow control of the confinement and propagation of light in very small dimensions, thereby enabling the design and integration of a large number and variety of optical microdevices on a single chip. Participating faculty are: H. A. Haus, E. P. Ippen, L. A. Kolodziejski, and H. I. Smith (Electrical Engineering and Computer Science); L. C. Kimerling (Materials Science and Engineering); and J. D. Joannopoulos (Physics).

Nanostructured Polymers

This group seeks to gain a fundamental understanding of the factors that control the way complex, electronically active polymer systems organize at the molecular level. The knowledge obtained from this work is expected to make it possible to control and significantly enhance the performance of electronic, magnetic, and optical devices based on these materials. The objective of this IRG is to develop the chemistry and processing needed to control the composition and spatial arrangement of constituents of multicomponent polymeric materials with novel electrical and optical properties. Participating faculty include: R. E. Cohen (Chemical Engineering); M. Bawendi, R. R. Schrock, and R. J. Silbey (Chemistry); and A. Mayes, M. F. Rubner, and E. L. Thomas (Materials Science and Engineering).

Electronic Transport in Mesoscopic Semiconductor Structures
The steady decrease in the size of semiconductor structures that has brought about the information age has also made it possible to study new electronic transport phenomena. Whereas classical transport theory describes the behavior of electrons in macroscopic systems (like conventional transistors), and the quantum mechanics of microscopic systems (like atoms) is reasonably well understood, the intermediate regime, termed mesoscopic, continues to reveal surprises and opportunities for novel electronic devices. In particular, whereas some mesoscopic effects are subtle, those resulting from confining electrons to reduced dimensions (in quantum dots, for example) are very dramatic. It is the goal of this IRG to understand the fundamental physical principles governing transport through and between semiconductor nanostructures created by both self-assembly and lithography techniques. Participating faculty include: R. Ashoori, M. A. Kastner, P. Lee, L. Levitov, and X.-G. Wen (Physics); M. G. Bawendi (Chemistry); and E. A. Fitzgerald (Materials Science and Engineering).

Microstructure and Mechanical Performance of Polymeric Materials
It is widely recognized by polymeric material producers that the key to polymer penetration into new product markets is through the optimization of industrial polymers on the market today. Thermoplastics offer major advantages in load-bearing applications because they are inexpensive, light-weight, easily processed into desired form, and recyclable. However, their mechanical properties limit their applicability. Recent advances in the ability to study material microstructure and deformation at multiple length scales have created tremendous new opportunities for developing methodologies for truly designing polymeric material systems. The goal of this IRG is to provide a mechanistic basis for tailoring polymer microstructure in order to achieve dramatic improvements in multiple mechanical properties by exploring and exploiting connections among microstructure, mechanisms and mechanical performance. Participating faculty include: A. S. Argon, M. C. Boyce, and D. M. Parks (Mechanical Engineering); and R. E. Cohen, K. K. Gleason, and G. C. Rutledge (Chemical Engineering).

Doped Mott Insulators
Several of the most interesting phenomena discovered in materials science in the past decade occur in a class of substances called Mott insulators. For example, high critical temperature (T_c) superconductivity occurs when certain copper oxide Mott insulators are doped to make them conducting. The effect of doping on the electronic and magnetic properties of Mott insulators is one of the great unsolved problems in condensed matter physics. The members of this IRG believe that the understanding of high T_c superconductivity, in particular, will require the solution of this larger problem. Apart from the intrinsic scientific interest, a deeper understanding of doped Mott insulators will pave the way for the exploitation and control of this technologically interesting class of materials. Participating faculty include: R. J. Birgeneau, M. A. Kastner, T. Imai, and P. A. Lee (Physics); F. C. Chou (Research Scientist, CMSE); and R. J. Cava (Chemistry, Princeton University).

INITIATIVE

Lithium Polymer Batteries
Rechargeable Li batteries with a solid polymer electrolyte (SPE) could be the ultimate power storage device due to their high potential energy density and low cost. Li-SPE imposes no limitations on the shape of the battery and is inexpensive to process, in contrast to current battery technology based on liquid electrolytes. Development is impeded by materials problems that are difficult because of the interaction between electronic, chemical and mechanical phenomena. The members of this initiative have expertise in electrochemistry polymer synthesis and characterization, oxide synthesis and first-principles electronic structure calculations. The objective is to develop the basic science behind rechargeable Li batteries, and use it to develop superior materials for this application. Initially, the focus will be on the development of a block copolymer solid electrolyte (BCE), and a high-energy density, low-cost, intercalation oxide for the cathode. With block copolymers, a microstructure can be formed that is locally liquid-like (allowing high ionic conductivity), but globally solid-like (giving the material mechanical rigidity). To design a novel cathode intercalation oxide, the group will use first-principles calculations to determine the factors that influence the phase stability of the intercalation oxide. Participating faculty include: G. Ceder, Y.-M. Chiang, A. Mayes and D. Sadoway (Materials Science and Engineering).

SEED PROJECTS

The center funded the following seed grants during the 2000–2001 year. The participating faculty and departmental affiliations follow the project title.

- Tuning the Emission Wavelength and Improving the Efficiency of Organic LEDs through Nanostructuring of Materials , V. Bulovic (EECS)
- Novel Fibers for Efficient Transmission of Electromagnetic Waves, Y. Fink (DMSE)
- Chemical Control of the Spatial Position of Quantum Dots in Thin Film Composites, K. Jensen (Chem E)
- Phonon-Polaritonic Bandgap Crystals, Keith Nelson (Chemistry) - IRG I associated seed.
- The Ideal Kagome Lattice: Synthesis and Magnetism of Pure and Single-Crystalline Jarosite-Type Compounds, D. Nocera (Chem)
- Magnetic Properties of Nanostructured Polymers, Caroline Ross (Materials Science and Engineering)

- Order in Strongly Interacting Quantum Many Particle Systems, S. Todadri (Physics)
- Actin: Paradigm for Active Polymeric Materials, A. van Oudenaarden (Physics)

Simon Mochrie, who was previously seed funded, has moved on to Yale University as of FY2002.

COLLABORATION WITH INDUSTRY AND OTHER SECTORS

CMSE collaborates with other laboratories and centers at MIT that carry out materials-related research and engineering with direct involvement of industry and other sectors, and CMSE facilities are modified in coordination with these organizations to assure that the overall spectrum of facilities offered by MIT is as broad as possible without unnecessary redundancy.

CMSE works in concert with a number of MIT industrial programs and centers to facilitate the transfer of the fundamental knowledge generated within the program to industry. MIT's Materials Processing Center (MPC) and Industrial Liaison Program (ILP), for example, work cooperatively to connect industry to the research carried out within the MRSEC program. The MPC, in collaboration with the ILP, will frequently invite members from industry to come to MIT to review recent developments by MRSEC researchers. This is done on an individual company basis or in the form of workshops and colloquia that are attended by representatives from many different companies. Connections made at these meetings have resulted in the industrial funding of more directed applied research; the transfer of technology to industry; and the establishment of a new center at MIT that focuses on the particular needs of an industry. The new Microphotonics Center recently created at MIT, for example, is a direct spin-off of the fundamental research carried out by our Microphotonics IRG. In this case, an MPC workshop focussing on the exciting discoveries of this IRG caught the interest of industry and initiated discussions about the establishment of a center devoted to the technological development of microphotonic materials and devices. In another example, an ILP/MPC organized meeting involving representatives from different companies and MRSEC faculty ultimately lead to the development of a new coating process for contact lenses. In this case, a connection was made between the polyelectrolyte thin film research ongoing within our Nanostructured Polymers IRG and the needs of the company CibaVision.

Our IRGs have ongoing collaborations with researchers from corporations and national laboratories, including Lucent Technologies, AMP, Allied Signal, Hewlett Packard Labs, Sanders-Lockheed-Martin, Xerox, 3M, Ciba Vision, Foster Miller, PPG, Amoco, DuPont, the Naval Research Laboratory, Sandia National Laboratory, the National Institute of Standards and Technology (NIST) and MIT Lincoln Laboratory. There are MIT-IBM beam lines for X-ray scattering at Brookhaven and Argonne Laboratories.

The SEFs are a critical feature of CMSE's collaborations with non-MIT personnel. The facilities are made available to any researcher from a nonprofit institution and to industrial researchers when equivalent facilities are not available commercially. Several of the IRGs participate in direct research collaboration with industry and other sectors. This is important for exchange of knowledge and the education of graduate students, for it provides them with direct experience of industrial research. CMSE currently maintains the following SEFs: Electron Microscopy, Analytical Crystal Growth, X-ray Scattering and Neutron Scattering.

EDUCATION, HUMAN RESOURCES, OUTREACH, AND AFFIRMATIVE ACTION

CMSE's programs contribute to the education of both undergraduate and graduate students in a variety of ways. A joint program with the Materials Processing Center (MPC) brings undergraduates from all across the nation to MIT in the summer to become involved in materials research. In addition, the center supports MIT UROP students working on CMSE research. The SEFs are also important in undergraduate education. Courses, such as those in X-ray scattering and electron microscopy, teach students to use processing and characterization facilities and to carry out research projects using the equipment. A course entitled Materials Synthesis and Processing, taught by the Department of Materials Science and Engineering and initiated with partial NSF support, uses the SEFs extensively. In addition, short courses are taught using the facilities during the Independent Activities Period. At the graduate level, CMSE plays a critical role in the education of almost all the students at MIT who do materials-related research. The CMSE colloquium series provides an opportunity for graduate students from many departments to learn about the broad range of research activities. In addition to students directly involved in the research of the IRGs, the shared facilities are used by graduate students from 11 academic departments.

CMSE also conducts outreach programs geared toward K–12 education. One of these programs is an intensive summer science and engineering day camp for middle school students. Another engages science teachers in research on campus. A third program piloted this past fall involved five Chelsea High School students in a machining and engineering design seminar taught on campus. In addition to these efforts, the center presented a day-long symposium on current materials research to 30 participants in the annual meeting of the Network of Educators in Science and Technology in June.

The Education and Human Resources Program is managed by a full-time education officer, who works closely with a faculty education program leader. Our programs include a summer REU internship program, an undergraduate

research opportunities program, research assistantships for underrepresented minorities, a teacher research experiences program, training courses in the facilities, regular seminars and other special programs.

CMSE is committed to providing opportunities to women and minorities through hiring and educational and research programs. Of the sixteen students who participated in the CMSE Undergraduate Research Opportunities Program, funded by the National Science Foundation as part of the MRSEC Program, six are women and ten are men. One of the UROP students is Hispanic.

The center offers three different programs that bring researchers to MIT during the summer. For the eighth year, CMSE and the MPC jointly sponsored a ten-week internship program. This year, however, the program was significantly expanded to include seventeen interns, rather than ten as in previous years. The participants were selected from applications submitted by approximately 150 undergraduates from other universities around the country. Six of the 17 scholars are women. The interns include Peter Anderson (University of Iowa), Christopher Bristow (Colorado State University), Colleen Colson (University of Southern Mississippi), Carl Dohrman (University of Illinois at Urbana-Champaign), Jonathan Hodges (Columbia University), Nicole LeBoeuf (Middlebury College), Andrew Lim (University of Connecticut), Nathan Lovell (University of Utah), Que Nguyen (Colorado School of Mines), Jack Perng (University of Illinois at Urbana-Champaign), Matthew Pilat (Providence College), Olivier Putzeys (Bucknell University), David Quinn (Villanova University), Melody Rattanapote (New Mexico Institute of Mining and Technology), Sharon Voshell (Rochester Institute of Technology), Kris Wood (University of Kentucky), and Rachel Zimet (Worcester Polytechnic Institute).

The third program, Materials Research Experience for Teachers, brings science teachers to campus for seven weeks to work with MRSEC faculty members and their research groups. This program, like the internship program, has been expanded this year to include a total of eight teachers. Three of these eight are former participants returning to develop classroom material based on their prior research experience at CMSE. This year's participants include three women. Lea Lewis-Santos and William McDonald teach middle school science in the Cambridge public schools. Daniel Menelly teaches eighth-grade science at the United Nations School in New York City. Hannah Sevian is a chemistry and physics teacher at Chelsea High School. Michael Doherty teaches physics at Andover High School. Finally, Sean Müller, Rebekah Ravgiala, and Raymond Sleeper teach chemistry, physics and biology at Merrimack High School in New Hampshire.

Five students from Chelsea High School participated in the freshman design seminar taught by Prof. Steven Leeb. Two of these students are women; two are Hispanic.

For the ninth year, the Center operated its successful science and engineering day camp for seventh- and eighth-grade students, many of whom are members of underrepresented minority groups. During the summer of 2000, the program hosted 14 students from two Cambridge public schools. The students included eight who are members of underrepresented minority groups. Seven of the students are girls and seven are boys. The students were supervised by faculty, staff, and MIT undergraduates Brinda Balakrishnan, Rishard Chen, and Alice Enevoldsen.

We continued the CMSE graduate minority research assistant (RA) program to support the development of doctoral-level scientists and engineers in the field of materials. During the past year, the Center provided RA support to two male graduate students who are members of underrepresented minority groups, one in the Department of Electrical Engineering and Computer Science and one in the Department of Mechanical Engineering. An additional male minority graduate student in the Department of Electrical Engineering and Computer Science was supported for the summer. A fellowship funds him during the academic year.

More information about the Center for Materials Science and Engineering can be found online at http://web.mit.edu/cmse/www/.

Michael F. Rubner

ENERGY LABORATORY

The Energy Laboratory and its associated Center for Energy and Environmental Policy Research (CEEPR) are multi-disciplinary organizations bringing together sectors of the MIT community with research interests related to energy supply, conversion, and utilization technology, as well as associated environmental, political, economic, geographical, and societal impacts. Professor Jefferson Tester is the Director of the Energy Laboratory and is supported by Associate Director Dr. Elisabeth Drake, Associate Director Dr. William Peters, and Administrative Officer John O'Brien. Professor Paul Joskow, with Dr. A. Denny Ellerman, Executive Director, directs the CEEPR. For more than 25 years, the Energy Laboratory has sustained a unique organizational structure to develop and implement strong single- and inter-disciplinary energy-related work at MIT. It provides a variety of research opportunities for students at all levels; from the Undergraduate Research Opportunities Program to postdoctoral studies. Our research programs in FY2001 supported about 110 undergraduate and graduate students, along with about 60 associated faculty members from twelve academic departments representing all five of MIT's Schools.

HIGHLIGHTS

Our graduate elective, Sustainable Energy (22.811J/10.391J/ESD66/11.371J/1.818J/3.564J), was offered for the fifth time in the spring of 2001 term. The course was taught collaboratively by members of the Energy Laboratory and the Nuclear Engineering and Chemical Engineering Departments, with participation of other experts from within and without MIT. Several students from the MIT School of Engineering, including the MIT ESD, completed the course, which included quantitative problem sets, topical papers and student-led case studies. The course instructors are preparing a new textbook for the course, with beta testing planned for the spring of 2002.

The Energy Laboratory research volume for FY2001 was over $7.4 million, including sponsored research and fund accounts.

The initial phase of the "Clean Diesel Fuel Research Initiative Program," collaboration between the Energy Laboratory (Sloan Automotive Laboratory) and the Chemical Engineering Department under the University of Alaska-MIT Partnership, received substantial industry support. The initial goal is to identify and assess the potential for significantly cleaner diesel fuels. A proposal on a longer-term research program has been developed.

The Energy Laboratory and the Nuclear Engineering Department have jointly developed a new Center for Advanced Nuclear Energy Systems (CANES). The center aims to create through research concepts for nuclear energy systems that promise more favorable economics, safety, proliferation resistance and environmental impact. The center's programs involve development and application of methods for the design, operation, and regulation of current and advanced nuclear reactors and fuel cycles. This requires advances in knowledge about traditional scientific and technical disciplines, modern methods of systems reliability, probabilistic safety analysis and decision analysis, together with human interactions and management science. The center will start operation in September 2000 with Professor Mujid S. Kazimi as its first Director.

CEEPR continued its research focus on emissions trading and electric utility restructuring during the 2000–2001 academic year. During this period, it received two major multi-year grants: one from the U.S. Environmental Protection Agency to continue the emissions trading research and the other from the Cambridge MIT Institute to conduct joint research with the University of Cambridge's Department of Applied Economics on electric utility restructuring in Europe and the U.S. and the associated improvement in electric utility productivity.

The Joint Program on the Science and Policy of Global Change continues to gain recognition as a leading center of research in its field. This recognition comes not only in the form of new associates and the continuing flow of financial support, but also in the form of more invitations to participate in expert reviews and assessments and to speak or otherwise participate in various meetings. In the past year, research and peer-review lags have been overcome and Joint Program research is appearing in a number of different journals, such as *Nature, Climatic Change, Journal of Climate, Foreign Affairs, the Review of Economics and Statistics*, and the *Energy Journal.* In the past year, about a dozen articles were published and another ten were accepted for publication.

We are continuing leadership work relating to technologies for carbon dioxide mitigation through carbon sequestration. We contributed to a major DOE report *Carbon Sequestration: Research and Development* (December 1999) and co-authored a paper on carbon sequestration for *Scientific American* (February 2000). Several research projects are on-going, including our participation in the International Collaboration on CO_2 Ocean Sequestration, a field experiment to take place in Hawaii in the summer of 2001. On July 1, 2000, we launched our Carbon Sequestration Initiative, an industrial consortium with seven charter members: American Electric Power, BP Amoco, Ford Motor Company, General Motors, Norsk Hydro (Norway), Texaco and TotalFinaElf (France). Finally, we were one of three universities asked to submit a proposal to BP Amoco for a major new research program on carbon management (we eventually lost out to Princeton).

The Energy Choices Program continues to pursue three major initiatives relating to its goal of seeking environmentally friendly energy technologies for a greenhouse gas-constrained world: the first is Eco-efficient Buildings for China, under the leadership of Professor Leon Glicksman and in collaboration with Tsinghua and

Tongii Universities and building developers at three locations in China; the second focuses on Nuclear Safety and Reliability Guidance for China, led by Professor Mujid Kazimi, with collaborations with Tsinghua University and other nuclear safety groups in China; and the third investigates Road Transportation Options for the Future, under the leadership of Professor John Heywood and Dr. Malcolm Weiss. A recent fourth initiative, funded by ABB Ltd. through the AGS, is the China Energy Technology Project, which examines responsible energy sector development for Shandong Province. A basic research activity involving Professors Greg Stephanopoulos and Tony Sinskey to investigate biotechnology applications to the energy industry is also continuing.

SELECTED CURRENT ACTIVITIES

Many of the laboratory's projects involve quantitative and cross-disciplinary study of complex energy and environmental systems. The Sloan Automotive Laboratory, directed by Professor John Heywood with participation from Professor Wai Cheng, Professor Doug Hart, Professor James Keck, Dr. David Schmidt, Dr. Tian Tian, Dr. Victor Wong and Professor William Green of the Chemical Engineering Department, continues promising research to improve engine performance, efficiency, and fuel utilization in internal combustion engines and reduce adverse emissions. Focusing on new engine and fuel technologies, the Engine and Fuels Research Consortium continues to explore critical fuel-air mixture preparation and emission formation mechanisms in developing engine concepts, with potential application to both gasoline and diesel engines. Complementing the engine and fuels studies, the Consortium on Lubrication in Internal Combustion Engines, involves major engine component and lubricant manufacturers, in addressing issues in oil consumption and engine friction reduction. Some members in these consortia also sponsor separate research projects on related topics of specific application to the individual sponsors. For example, Professors Wai Cheng and John Heywood work with Ford Motor Company on three projects related to engine transients: fuel-air mixture preparation behavior during start-up, emission benefits of engine operation in hybrid electric vehicles, and actual in-use vehicle emissions in stop-and-go traffic. Sloan Laboratory researchers are also involved in assessing new vehicle and propulsion system technologies for future road transportation use. The Sloan Laboratory also engages actively in basic combustion research on advanced engine systems with US DOE support, and in engine emission research with support from the EPA Research Center on Airborne Organics. The initial phase of the "Clean Diesel Fuel Research Initiative Program," collaboration between the Energy Laboratory and the Chemical Engineering Department under the University of Alaska-MIT Partnership, is receiving substantial industry support. The initial goal is to identify and assess the potential for significantly cleaner diesel fuels. Plans for a longer-term research program have been developed and are expected to be funded shortly. The proposed research will complement extensive fuel testing programs being conducted elsewhere and will address: Engine Technology/Fuels Interaction; Fuel Processing Technology; and Special Environmental and Economic Factors.

The Energy Laboratory interacts closely with the Center for Environmental Initiatives (CEI—directed by Professor David Marks) through several major sustainable energy initiatives described later in this section. Administrative duties are also provided to the CEI by the Energy Laboratory staff. Other interactions include the Building Technology program (led by Professor Leon Glicksman) in research on energy efficient, "healthy" buildings. The Energy Laboratory is also an active member of the Program for Environmental Education and Research (PEER) under the leadership of Professors Jeffrey Steinfeld and Philip Gschwend.

The Energy Laboratory held its third fall workshop for participants and sponsors of the program on Energy Choices in a Greenhouse Gas (GHG) Constrained World. This initiative is an outgrowth of collaboration with the Joint Program on the Science and Policy of Global Change (co-directed by Professors Henry Jacoby and Ronald Prinn) to improve the technology characterizations in their Integrated Global Systems Model, as well as from growing concerns about the role of present and future energy choices on the local, regional, and global environment. Under the leadership of the CEI and its role in the Alliance for Global Sustainability (AGS), a collaboration between MIT, Eidgenössische Technische Hochschule (ETH-Switzerland), and the University of Tokyo, the Energy Choices Program interfaces with the Joint Program and other AGS activities. This year the focus was on the road transportation options for the future. At present, the program has received funding from the AGS, five industrial sponsors, and the V. Kann Rasmussen Foundation, which has established the MIT Venture Fund for Energy Choices, to facilitate the development of the larger program, committing funding of $2.35 million over a four year period. Several Energy Choices research activities are underway:

Faculty and students in Building Technology are conducting a major program of sustainable building design and technology for developing countries. We are actively cooperating with colleagues at Tsinghua University and Tongji University and Chinese developers and designers. Our focus is on residential buildings in large Chinese cities. Projects include the design of four high-rise residential structures in Beijing, two mid-rise multi-story housing units in Shanghai's Taidong Residential Quarter, and a low-rise residential community in Shenzhen City. The goal of these projects is the development of demonstration buildings that use appropriate technologies and designs as a teaching tool and example for future projects in Chinese cities. New technologies are being evaluated such as night cooling, solar driven dehumidification, and ground coupled heat pumps, as well as incorporating traditional technologies such as shading and natural ventilation. Schematic designs for the three developments will be completed during the summer of 2000.

The Building Technology group also is cooperating with colleagues at the University of Tokyo in a study dealing with reduction of pollution from megacities such as Tokyo or Shanghai. This technical work is being carried out in cooperation with the University of Tokyo and the Swiss Federal Institute of Technology. In this project,

technologies such as ground source heat pumps and advanced facades are being evaluated. Ground source heat pumps use low-grade geothermal energy to improve efficiency for both heating and cooling of buildings. The ground source air conditioner, which stores or extracts heat underground, will significantly reduce urban heat island effects in the summer. We have undertaken a comprehensive study of advanced building facades that have air circulation between multiple glazing as well as blinds to control solar input and daylighting. These facade systems, when properly used, will reduce energy for air conditioning as well as artificial lighting. They will also improve interior comfort and ventilation.

Professor Kazimi is leading a collaboration with other faculty members at MIT and Tsinghua University that aims to provide China's growing nuclear energy sector with a firmer foundation for development of nuclear safety standards. That includes the evolution of the list of design basis accidents to be more risk informed, and the application of innovative technologies for safety monitoring of plant operations. In April of 1999, the project organized a major international workshop on these subjects in Beijing. Visits to operating nuclear plants in China are planned for the coming year to share some of the international research findings and develop collaborations that will improve performance and safety.

Professor Heywood and Dr. Weiss have completed the first phase of an assessment of new vehicle and fuel technologies for future road transportation, considering the increasing concerns about limiting both greenhouse gas emissions and criteria pollutants such as particulates and nitrogen oxides. The work started with a critical review of existing assessments (many of which are partial system views with a variety of different assumptions), and then conducted a life cycle assessment of potential fuel/vehicle systems for the 2020 time frame. Finally, the implications of transitions to these future transportation technologies to each of the major stakeholders in the transportation industry, including customers and the government, were evaluated. The focus is to identify barriers and opportunities for accelerating the adoption of such new technologies where they offer advantages relative to the evolving fleets of cars and trucks. A draft report is currently in peer review and will be published later in 2000, following an interactive workshop that focuses on the report and tries to identify responsible pathways for the future.

The AGS China Energy Technology Program (CETP), where Swiss, Japanese and Chinese colleagues, along with the Analysis Group for Regional Electricity Alternatives (AGREA) team are helping Shandong Province identify and develop environmentally responsible electric sector development strategies.

Professors Sinskey and Stephanopoulos continue to receive seed money under the Energy Choices Program to conduct preliminary studies on technology platform development for the applications of metabolic engineering to the energy industry. This research is part of a larger program that includes additional sources of funding within the chemical engineering department.

Professor Jack Howard directs the EPA Center on Airborne Organics. A major goal of this center is to better understand pollution of ambient airsheds by energy and other industrial sources and to use that understanding to prescribe new means of detecting and tracing organic pollutants and new methodologies for preventing pollutant emissions altogether. Specific projects focus on sources, atmospheric transport and transformation, monitoring, and engineering controls for organic pollutant vapors and aerosols. To provide a strong group of experts to address these issues, the center operates as a consortium of MIT, the California Institute of Technology, and the New Jersey Institute of Technology. Professors John Seinfeld (Caltech) and Robert Pfeffer (NJIT) are associate directors. MIT scientists participating in Center research projects have included Professors Paul Barton, Wai Cheng, William Green, John Heywood, Jack Howard, Mario Molina, John Vander Sande, and Dr. Arthur LaFleur. For several years, the Center has hosted an annual Summer Symposium on high visibility technology and policy topics in ambient air pollution. In July 2000, the focus of this meeting was on The Future of Diesel: Scientific Issues. The meeting was chaired by Dr. Robert Slott, Consultant to the Energy Laboratory. Presentations and panels addressed the present status of the importance of the diesel engine in today's economy, and various issues related to measurement, monitoring and prediction of nitrogen oxide and particulate emissions from diesels. Subsequent sessions addressed diesel emissions regulations in the U.S., Europe, and Asia, and issues in implementing clean diesel technology for the future. Two panels then took up health effects and risk assessment of diesel emissions, and the future outlook for diesel propulsion. Reports of the center and of Summer Symposia are available on the center website.

The field of carbon management and sequestration is attracting much interest due to increasing concerns about global climate change. Our continuing work on carbon sequestration technologies focuses on three areas: assessment, education/outreach, and basic research. Howard Herzog leads this effort. We have five projects under this heading:

- On-going assessment and outreach work for the National Energy Technology Laboratory (NETL) of the DOE (in collaboration with Dr. Drake).
- An integrative assessment of carbon sequestration technologies co-funded by the DOE's Office of Fossil Energy and Office of Science (includes collaboration with Professor Jacoby and the Joint Program).
- An international collaborative effort between Japan, Norway, Canada, Australia, and the United States on CO_2 Ocean Sequestration funded by NETL.
- The objective of this project is to investigate the technical feasibility, and improve understanding, of the environmental impacts of CO_2 ocean sequestration. A field experiment will take place in the summer of 2001 off the Kona Coast of Hawaii (in collaboration with Dr. Eric Adams of the Parsons Laboratory).

- Participation as a member of the National Center for Research on Carbon Sequestration in the Ocean, funded through the DOE's Office of Science through Lawrence Livermore National Laboratory (in collaboration with Dr. Eric Adams of the Parsons Laboratory and Professor Bernhardt Trout of Chemical Engineering).
- The Carbon Sequestration Initiative, an industrial consortium on Carbon Management under the Energy Choices Program. Our seven charter members are: American Electric Power, BP Amoco, Ford Motor Company, General Motors, Norsk Hydro (Norway), Texaco and TotalFinaElf (France).

The University Research Consortium (URC) of the DOE Idaho National Engineering and Environmental Laboratory (INEEL) has continued to support research projects at MIT, primarily in nuclear technologies, under the new contractor, Bechtel, which took over management of INEEL in October 1999. With support from the URC, a three-year program was initiated in October 1998 for development of advanced nuclear technology through an MIT/INEEL Strategic Nuclear Research Collaboration (SNRC). The aim of the SNRC is to investigate options that promote nuclear technology as a source of electricity in the next century. In its second year, the program had a total funding at MIT of $1.2 million per year tied with about $1 million funding at INEEL. Four projects were funded under this initiative: The Modular Gas Cooled Reactor (MPBR) under the direction of Professors Andrew Kadak and Ronald Balinger; The Lead-bismuth Cooled Actinide Fueled Reactor (AFR) under the direction of Professors Todreas and Kazimi; Advanced Fuels for Light Water Reactors under the direction of Professors Kazimi and Driscoll; and Methodology of Performance-Based Regulation under the direction of Professors Apostolakis and Golay.

A major collaborative program was started in 1985 between MIT and the INEEL, with funding from DOE Basic Energy Sciences. Today this collaboration seeks new engineering understanding to improve efficiency and materials conservation in energy-intensive processes. Dr. Drake manages the MIT portion of the program, with one project led by Professor David Parks and another by Professor Thomas Eagar. The present project cycle will continue to fund the collaborative research through the end of calendar year 2003. The annual review meeting was held at the MIT Energy Laboratory in June 2000.

With DOE funding, in the Heat Transfer Laboratory, Professor Glicksman and students are carrying out studies of heat transfer and hydrodynamic scale-up in fluidized bed combustors. An experimental scale model of a large-scale commercial fluidized bed has been operated to study overall flow behavior. This will provide design guidance for a larger scale commercial unit. The commercial unit promises to achieve overall thermal efficiency of 50 percent or higher. This unit will also control the emissions when dirty fuel is burned. A key problem in the design of fluidized bed combustors is the proper sizing of heat transfer surface area. These fundamental studies will allow accurate prediction of the heat transfer to the bed walls. Recent research has focused on measuring the turbulence in the bed; this is the key to understanding the transport of particles from the bed core to the heat transfer surfaces at the wall.

Research in competitive power systems continues to advance. Led by Dr. Marija Ilic, research in this area includes the consortium New Concepts and Software for Competitive Power Systems: Operations and Management, and the ABB sponsored Distributed Power Industry of the Future project. Mr. Stephen Connors helps coordinate the Competitive Power Systems group's activities. Funded by ABB, Constellation Power Source, Electricite de France, TransEnergie U.S. and the Department of Energy's Energy Information Administration, the New Concepts consortium is devising techniques for market players and market monitors to work effectively in a competitive electric industry. Research thrusts include the development and application of congestion management structures and computational capabilities for regional grid operators, price-forecasting techniques for generators and power marketers, and revised criteria for measuring the adequacy and reliability of power supplies. The Distributed Power Industry project focuses on the technical, economic and regulatory challenges that distributed resources pose to distribution system stability. The project, that will hopefully evolve into a consortium in the coming year, is also addressing alternative business models and regulatory structures, which may enable, or constrain, the deployment and use of consumer-based electricity generation, storage, demand control, and power quality enhancement. Also participating in the Distributed Power project are Professors Paul Kleindorfer from the University of Pennsylvania's Wharton School of Business, and Ingo Vogelsang from Boston University. The Energy Lab's contributions in these areas have been magnified by Dr. Ilic's part-time efforts at the National Science Foundation, in the Electrical and Communication Systems Division. As Program Director for Power and Energy Systems, Dr. Ilic has participated in many academic, professional, industry conferences, and workshops, and helped shape the national debate on the future of power systems research, education and practice.

Energy Lab research in the area of strategic planning for energy infrastructures and environmental performance is led by Mr. Stephen Connors. The scenario-based multi-attribute tradeoff analysis approach, developed in the 1980's by Energy Lab researchers, is the primary tool used by the Energy Lab's Analysis Group for Regional Electricity Alternatives (AGREA). Current AGREA projects include studies of Switzerland's, China's and Romania's electricity alternatives, as well as an integrated assessment of the air pollution reduction alternatives for the Mexico City Metropolitan Area. The electricity planning efforts are under the sponsorship of the multi-university Alliance for Global Sustainability, which involves researchers from Switzerland and Japan. While the Swiss case study is nearing completion, the Shandong Province, China case study is now in its second year, with the Romanian case just getting underway. In addition to the multi-attribute tradeoff analysis approach, all three case studies are designed to interact with local decision-makers to ensure the research is relevant, attuned to local conditions, and has a better

chance of influencing the decisions of local officials. This is true also of the Mexico City case study. This project, sponsored by the Consortium on Environmental Challenges, includes numerous Mexican institutions and researchers, as well as scientists from the Harvard School of Public Health. On the MIT side, researcher are drawn from the Departments of Earth, Planetary and Atmospheric Sciences, Civil and Environmental Engineering, Chemical Engineering, and Urban Studies and Planning, and labs and centers such as the Energy Lab, The Center for Transportation Studies and the Center for International Studies. AGREA plays a central role in this effort due to its scenario planning approach, and extensive experience in interacting with local stakeholders.

The Energy Laboratory continues a program of scientific and engineering research to support technologies for destroying military and other hazardous wastes by supercritical water oxidation (SCWO). MIT studies provide new understanding of various important practical issues including kinetics of waste destruction, corrosion prevention, phase equilibria, salt transport and deposition, reactor modeling, and process simulation. Recent work in collaboration with a small business in the computational fluid dynamics sector has focused on development of mathematical models for SCWO reactors (U.S. Army STTR funded). Another Army-funded project focuses on studies of the kinetics of waste destruction. Related MIT projects are concerned with the use of supercritical fluids as media for "green chemistry" and to reduce emissions from diesel engines. MIT research on supercritical fluids is led by Professor Tester and has involved Professors Tomas Arias (now at Cornell), David Cory, Rick Danheiser, Peter Griffith, Jack Howard, Ronald Latanision, Kenneth Smith and Jeffrey Steinfeld, Dr. Michael Modell, Dr. William Peters, Mr. Howard Herzog, and Dr. Frederick Vogel, as well as visiting faculty from Merrimac College, Professors Angelike Rigos and Katherine Swallow, several MIT students pursuing graduate degrees in engineering, and visiting students from ETH Zurich.

CEEPR AND JOINT PROGRAM

The Center for Energy and Environmental Policy Research (CEEPR) is an activity, jointly sponsored at MIT by the Energy Laboratory, the Department of Economics, and the Alfred P. Sloan School of Management, that funds policy-related research in energy and environmental economics. The center and the joint program receive financial support from corporate sponsors, government agencies in the U.S. and Norway, and one foundation. In addition, affiliate relations are maintained with several environmental groups and other policy-oriented research groups in other countries.

For the past several years, CEEPR's principal research activity has been conducted under the auspices of the Joint Program on the Science and Policy of Global Change, sponsored in collaboration with MIT's Center for Global Change Science. This program, led by Professors Jacoby and Prinn, draws on MIT's traditional strengths in science and economics to conduct the serious interdisciplinary work needed to provide a basis for global climate policy. The now seven-year-old Joint Program is one of the world's leading centers for the Integrated Assessment of Climate Change. The Integrated Global Systems Model provides the basis for a number of reports, articles, and presentations on the science and policy of global warming. The principal faculty and researchers are frequently requested to attend scientific and expert group meetings related to climate change. Contributions to the Joint Program remain stable with annual funding now approximately $2.8 million. The work of the Joint Program is supported financially by a number of corporate sponsors in North America, Europe and Japan, the U.S. governments and the Vetlesen Foundation.

CEEPR research outside of the Joint Program has focused on four areas: emissions trading; electricity markets; and energy futures, forwards and arbitrage. By merit of its research on the U.S. SO_2 emissions trading program, the center has become an authority on the actual functioning and implementation of emissions trading as an instrument for the more efficient achievement of environmental goals. As an example, CEEPR is assisting in the design of a SO_2 cap and trade system for China under a cooperative agreement between the Chinese and U.S. governments. As the electric utility industry is being restructured in many countries, markets in electricity are emerging for the first time. CEEPR's research examines the functioning and performance of these new markets. Particular emphasis is placed on how restructuring decisions with respect to asset ownership, transmission access, and customer choice shape these markets. Finally, research on energy futures, forwards and arbitrage applies an area of expertise at the Sloan School to the emergence of highly liquid spot, futures and forward markets for crude oil and natural gas and to the current development of such markets for coal and electricity.

NEW INITIATIVES

We have formally launched the Carbon Sequestration Initiative (CSI), our industrial consortium on carbon management with a founding group of seven organizations. The CSI will function as a facilitating web information network for members and also will seed selected relevant innovative research ideas.

In the area of supercritical fluids, we are expanding our emphasis from research in support of waste destruction/decontamination to chemical synthesis and other applications that capitalize upon the remarkable solubilizing power, phase relationships, and species transport behavior of fluids near and above their critical point. A new industrially-supported project to determine the feasibility of using compressed water at elevated temperatures as a medium for clean chemical reactions, led by J. Tester and W. Peters, began in July of 2000.

In the area of electrothermal (plasma) processing, W. Peters, J. Howard, and J. Tester plan to pursue applications in extractive metallurgy, wastes recycling, and conversion of biomass and fossil resources to hydrogen, chemical

feedstocks, and clean liquid fuels. This work will build on our prior studies of plasma smelting to produce light metals from oxide ores, including a one-year industrially funded exploratory study of a new approach to producing aluminum metal.

At the beginning of the next fiscal year, beginning in July 2001, the MIT Energy Lab will be merged with the Center for Environmental Initiatives to create the MIT Laboratory for Energy and the Environment (LFEE).

More information about the Energy Laboratory can be found online at http://web.mit.edu/energylab/www/.

Jefferson W. Tester

FRANCIS BITTER MAGNET LABORATORY

The Francis Bitter Magnet Laboratory (FBML) has continued to make notable advances in several areas of science and engineering involving high magnetic fields. The research program in Magnetic Resonance (nuclear magnetic resonance (NMR), and electron paramagnetic resonance (EPR)) has continued to grow and remains the largest effort at the FBML. The program is funded primarily by the NIH and DOE, and involves ~20 NMR and EPR magnets and spectrometers.

A few of this year's highlights:

Professor Robert G. Griffin, together with Professor Gerhard Wagner of Harvard University, continue to operate the MIT/Harvard Center for Magnetic Resonance, a collaborative research effort between MIT and Harvard Medical School. The center is supported by a NIH Research Resource grant that was renewed for five years. Recently the NIH issued an RFA to support the purchase of 900 MHz spectrometers and we plan to submit applications to this program in fall of 2001.

Professor Harald Schwalbe joined the Department of Chemistry in October 1999. His offices and laboratory space are presently located at the FBML. Professor Schwalbe's area of research is focussed on solution NMR studies of protein folding and structures of ribonucleic acids.

Professor Cory and his colleagues continue to make advances in the theory, practice and implementation of quantum information processing. Over the past year this has included the first exploration of decoherence control via noiseless subsystem encoding, and the first NMR demonstrations of entanglement transfers and quantum erasers.

Dr. Yukikazu Iwasa received funding from NIH to construct a very high field, wide bore 700 MHz NMR system. The system is essentially complete and has successfully passed most tests and we anticipate delivery in a few weeks. A unique feature of the magnet is a ±500 Gauss sweep coil essential for dynamic nuclear polarization experiments.

Dr. Jagadeesh Moodera has continued to strengthen his research efforts in condensed matter physics through collaboration with various universities and industries, as well as the ONR and NSF. In addition, he has continued his mentoring of graduate students, undergraduate and high school students by providing research opportunities within his lab. Dr. Moodera received the 2000 TDK Research Award for his pioneering studies in spin tunneling.

RESEARCH ACTIVITIES

Professor David G. Cory

Quantum Information Processing

Professor Cory and his students continue to explore NMR approaches to quantum information processing (QIP) through a set of collaborations with Dr. Timothy Havel (NED), Professor Seth Lloyd (Mechanical Engineering), Professor Eddie Farhi (Physics), Dr. Raymond Laflamme (LANL), Dr. Emanuel Knill (LANL), Dr. Jeff Yepez (AFRL). Our liquid state NMR implementation of quantum information processing is now being implemented at the 10 qubit level; a complexity far beyond other approaches to quantum information processing.

We have started to construct a new scheme for extending the success of NMR approaches to QIP to larger systems via a solid state device capable of coherently controlling 10–30 qubits. This is essential for exploring quantum error correction. We have also obtained funding to explore lattice gas computations on classically distributed quantum computers.

NMR of heterogeneous semi-solids

In collaboration with Dr. Samuel Singer, and Dr. Pabitra Sen of Schlumberger-Doll Research Laboratory we have continued to explore the structure and fluid dynamics of complex media. This has led to a new prognosticator of tumor grade for soft tissue sarcomas, and a new measure of local organization for heterogeneous samples. For the first time, the effects of motion can be cleanly separated from the overall spin dynamics which provides a simple and direct means of characterizing micron scale structures.

NMR imaging of neuron structure and function
In collaborations with Dr. Alan Jasanoff (a Whitehead Fellow at MIT), the neuron structure and response of blow flies is being explored at high resolution via NMR microscopy. The use of blow flies provides a stable and well characterized test bed, while simultaneously permitting near cellular resolution in the NMR. The goal of the program is to observe neuron activity in living/functioning tissue with the markers being directly traceable to neuron biochemistry.

Professor Robert G. Griffin
A web site describing some of our research can be found at http://web.mit.edu/fbml/cmr/griffin-group/.

High Frequency Electron Paramagnetic Resonance (EPR)
About a two years ago the capabilities of the 140 GHz EPR spectrometer were dramatically extended by the incorporation of a four-phase microwave pulse-forming network and amplifier with 30 mW of output power. We are in the process of a further upgrade to ~110 mW. The greater microwave power and phase switching capability allows us to develop and perform sophisticated pulsed EPR techniques. In particular, we are working on developing new pulsed methods for spectral filtering, electron/nuclear cross polarization and multiquantum EPR experiments for measuring long-range distances (10-30 Å) in spin labeled proteins and peptides. In addition, the 140 GHz pulsed Electron-Nuclear Double Resonance (ENDOR) capability has already been used to examine a number of systems. For example, the increased sensitivity, resolution, and orientation selection available in the ENDOR experiment at this high frequency/field has enabled us to determine in detail the electronic structure of the tyrosyl radical of ribonucleotide reductase. (RNR) ENDOR studies of the RNR inhibitor complexes are in progress.

Structural Studies of Alzheimer's Disease Amyloid
Amyloidoses are a group of disorders due to peptide or protein misfolding and characterized by the accumulation of insoluble fibrillar protein material in extracellular spaces. Sixteen different peptides are known to form amyloid-like aggregates, and are involved in several diseases. ß-amyloid (Aβ) in Alzheimer's disease, the prion protein PrPc converts to PrPsc leading to the transmissible spongiform encephalopathie, and the synuclein protein is responsible for Parkinson's disease.

During the last two years, we developed methods to obtain large amounts of fibrillar peptide material. And to maintain this material in a state suitable for MAS NMR experiments. We have used these techniques in a collaborative study of the structure of 11-mer fibrillar peptides in collaboration with Professor Chris Dobson of Cambridge University. The peptides are derived from transthyretin and to date have yielded excellent spectra. We are presently in the process of assigning these spectra and plan by next year to have a structure of a fibrillar system.

Dynamic Nuclear Polarization
During the past year we have improved the operation of the 140 GHz system and have obtained the initial MAS spectra exhibiting an enhancement of ~15 at ~90K. We have continued to operate the 250 GHz gyrotron on a routine basis and are near to initiating MAS DNP experiments with the device. At present these represent the highest frequency DNP experiments ever performed, and more importantly suggest that even higher frequency operation will be successful. In collaboration with the PSFC we have designed and are constructing a 460 GHz gyrotron that will be used in conjunction with the 700/89 widebore magnet which is installed and operating.

Dipolar Recoupling
Over the last decade we have been heavily involved in the development of techniques to measure distances and torsion angles in solids. The goal is to be able to determine the structure of membrane proteins, amyloid fibrils, etc with solid state NMR. This past year we completed the initial structure of a small peptide. We anticipate that with increased signal to noise available from DNP experiments that these methods will be applicable to a large number of systems not accessible to solution NMR and X-ray crystallographic investigations.

Center for Magnetic Resonance
The Center for Magnetic Resonance has completed its 25th year of operation as a facility open to scientists needing access to high field NMR equipment. During this year, 53 projects were worked on by 90 investigators, from departments within MIT including Chemistry, Physics, and Nuclear Engineering, as well as users and collaborators from institutions outside of MIT such as Harvard University, Brandeis University and Brigham and Women's Hospital. Work resulted in 48 publications in print or in press.

Highlights of work conducted at the center include advances in high frequency dynamic nuclear polarization of proteins (DNP), time resolved studies of protein folding, structures of large proteins, and high frequency EPR and ENDOR.

Recently the NIH issued an RFA to support the purchase of 900 MHz spectrometers and we plan to submit applications to this program in fall of 2001. The 900's will be operated as part of the CMR. In addition we anticipate applying for additional widebore 800 class systems in the next year or two.

Dr. Yukikazu Iwasa

We are involved in Research and Development of superconducting magnet technology, particularly of high-temperature superconductor (HTS). Specific HTS-related projects that the Magnet Technology Division (MTD) is currently involved include: development of a flux pump for NMR superconducting magnets that incorporates HTS inserts; phase 1 project of a 3-phase, 6 year program to complete a 1-GHz NMR magnet that includes an HTS insert; development of vapor-cooled current leads that combine HTS and copper sections; study of stability/protection of HTS magnets used in electric power devices; and development of a "noise-free" NMR magnet system. Topics 4 and 5 apply solid nitrogen technology recently developed by the MTD. These projects are briefly summarized below.

Flux Pump for NMR Superconducting Magnets

Flux pump is considered a viable technology for achieving the 1-GHz milestone. By allowing precisely metered quantities of magnetic energy to be injected into a slightly dissipative superconducting coil, e.g., an HTS insert coil in a 1-GHz magnet system, a flux pump can make the dissipative coil operate in an effectively persistent mode. Started on June 1, 2000, we have since designed, built, and successfully operated a model flux pump to confirm its experimental results with analysis. Presently, we are designing a prototype flux pump that will be coupled to a Phase 1 LTS/HTS NMR magnet presently under construction in the MTD, described below.

HTS Insert Coil for 1-GHz NMR Magnet

The MTD is presently undertaking Phase 1 of a 6 year 3-Phase project to complete a high-resolution 1-GHz NMR magnet. In each phase, an HTS insert coil will be designed, built, and operated in a background LTS magnet. Started on October 1, 2000, we have since designed the HTS insert and presently are in the process of winding it. We expect to perform critical current measurements of the insert in a high background field at the National High Magnetic Field Laboratory, Tallahassee, FL in September 2001, and afterward proceed to assemble the insert into a background NMR magnet already available in the MTD.

Vapor-Cooled HTS/Copper Current Leads

As a DOE-sponsored STTR project, we collaborated with American Magnetics, Inc., Oak Ridge, TN, to successfully complete Phase I program to develop a new type of commercially viable vapor-cooled HTS/Copper current leads. This new type of current leads is based on a concept recently developed in the MTD and patented by MIT.

A large heat capacity of solid nitrogen in the temperature range 10–60K is considered beneficial for operation of HTS magnets in some applications.

Stability/Protection of HTS Magnets

The large heat capacity of solid nitrogen impregnating the winding of an HTS magnet in an electric power device limits the temperature rise in the HTS winding subjected to fault-mode overcurrent pulses. We are investigating quench/recovery processes of YBCO-coated tape subject to transient heating in the presence and absence of a minute amount of solid nitrogen in the HTS winding.

"Noise-Free" NMR Magnet

A "noise-free" magnet/cryo-cooler NMR system incorporates solid nitrogen in the system. The large heat capacity of the solid nitrogen permits "noise-free" operation of an NMR system with its cryocooler idled over a period long enough for measurement. (Microphonics from the running cryocooler precludes microscopic scattering measurements.) Starting June 1, 2001, we began development of a commercially viable compact NMR magnet system based on this concept as an NIH STTR Phase I project in collaboration with American Magnetics, Inc., Oak Ridge, TN.

Dr. Jagadeesh S. Moodera

In condensed matter physics, in particular magnetism, our research continues to make significant contributions to both fundamental science and industrial application. Our basic investigation emphasizes interfacial exchange interaction and spin transport in thin film structures. Using our molecular beam epitaxy (MBE) system, our research seeks to contribute to the understanding of the spin properties of conventional materials and to unraveling the spin properties of certain novel magnetic compounds that have a high potential for technological application. Our research in these materials has already shown the possibility of a four-level memory/logic element. Several companies, including IBM, HP, Motorola, TDK and Fujitsu, are developing this structure for application in digital storage. In this context, we are continuing national and international collaborative research efforts with scientists and faculty from national laboratories, U.S. universities, the University of Paris at Orsay, the University of Eindhoven, Tohoku University, the Tata Institute of Fundamental Research and the Ukrainian Academy of Sciences. Exchange of scientists and graduate students is a part of this program.

Recently we have begun a program on the thin film studies of a recently discovered novel superconductor which has a high potential for application in Josephson junction based computers, logic elements, mixers switches and sensors. The results have been quite promising. In the area of semiconductors, our continued collaboration with Hewlett-Packard Company has been valuable in searching for far future material for atomically resolved storage (>Terabytes/in^2). We are exploring the materials with the appropriate properties and giving HP the fundamental information necessary for their program. In this direction we have been successful in identifying a possible candidate material from among thousands of compounds. There is ongoing collaboration with other companies such as NVE Inc., TDK (Japan) in the field of magnetism.

Five postdoctoral scholars, four undergraduates and six high school students have taken part in Dr. Moodera's research. One of the undergraduates did her B.S. thesis and another one is carrying out her thesis under the PI's supervision. The high school students won several science competitions, including a semifinalist in Intel-Westinghouse Science Competition, as well as other regional and state level awards. Research resulted in four publications including a feature article for Physics Today and over eight invited talks at various national and international conferences, universities and laboratories. Dr. Moodera has been invited to spend some time at Eindhoven Technical University as a visiting professor. He has taken part at the national level magnetism committee policies and meeting initiatives, as well as serving in the scientific board of international meetings. There are nine research grants under Dr. Moodera's supervision, including four NSF, two ONR, one NASA and from two other companies. Dr. Moodera was elected as Fellow of American Physical Society in the fall of 2000.

Dr. Harald Schwalbe

Our research is focussed on the studies of structural and kinetic aspects of protein folding using high resolution NMR spectroscopy. It is now known that the process of protein folding and unfolding is coupled to a wide range of biological phenomena from the regulation of cellular activity to neurodegenerative diseases. The nature of the conformations sampled in non-native proteins is crucial for the understanding of all these phenomena. In the last year, we have used a combination of nuclear magnetic resonance spectroscopy and site-directed mutagenesis to study unfolded states of the protein lysozyme. Extensive clusters of hydrophobic structure exist in the wild-type protein even under strongly denaturing conditions. These clusters are, however, dramatically destabilized by a single point mutation, W62G, located in the interface of the main structural domains in the native state. The results provide remarkable evidence for the presence and exact location of long-range cooperative interactions within the ensemble of non-native conformations both in the presence and absence of native disulfide bonds. In a second research project, we try to understand the importance of these non-native conformations for the kinetics of protein refolding. Using time-resolved Photo-CIDNP NMR methods, we were able to characterize the Ca^{2+} induced refolding of a-lactalbumin with unprecedented temporal and site resolution. Refolding at constant denaturant concentration was initiated by laser induced ion release from photolabile chelators. The NMR data allows derivation of aspects of the structure of the intermediate populated after 200ms. Part of the polypeptide chain in the b-domain of a-lactalbumin samples non-native conformations while a hydrophobic core of the a-domain is formed.

FACILITIES

During the past year, we have started the renovation process for the magnet cell to accommodate the 700/89 system. We are also beginning to discuss the renovations for the 900 MHz instruments.

EDUCATION AND PERSONNEL

The laboratory contributes to undergraduate education by participation in the Undergraduate Research Opportunities Program (UROP) a program that encourages and supports research-based intellectual collaborations of MIT undergraduates with Institute faculty and research staff. In addition, the laboratory has 20 full-time graduate and 20 postdoctoral fellows performing research.

FUTURE PLANS

Discussion of for space for the 900 MHz magnets is under discussion and proposals are being prepared for acquisition of this system.

We are discussing plans to place a 3 Tesla imaging system on the first floor of Building NW14. The system will be used by investigators from the Deptartment of Brain and Cognitive Science and others interested in functional magnetic resonance imaging.

In the longer term we also plan to complete construction of the second floor magnet hall, and instruments currently housed on the fourth and fifth floors will be relocated in order to create a comprehensive Center for Magnetic Resonance.

Robert G. Griffin

HAYSTACK OBSERVATORY

The Haystack Observatory, located in Westford, MA, is an interdisciplinary research center focused on the advancement of radio science with applications to astronomy, geodesy, and atmospheric physics. The current priority of the astronomy program at Haystack is to develop large radio interferometric arrays of telescopes that will achieve high sensitivity and resolution needed for the study of the structure of our galaxy, the early Universe, and transient astronomical events. The astronomy research program is carried out under the auspices of the Northeast Radio Observatory Corporation (NEROC), a consortium of eleven educational and research institutions in the northeast. The primary objective of the geodetic research is to improve the accuracy of measurements of Earth's orientation parameters by enhancing the bandwidth of the observations through innovative instrumentation development. The current goal of the atmospheric research is to understand the impact of solar disturbances on the Earth's upper atmosphere through radar and optical measurements. An important component of the observatory's mission is to support the training of students by providing opportunities for them to link their education with research through the disciplines practiced at the observatory. The observatory receives financial support primarily from federal agencies including the National Science Foundation, the National Aeronautical and Space Administration, and the Department of Defense, as well as from industrial sources.

INSTRUMENTATION

The Haystack Observatory instrumentation consists of the following facilities:

- A 37-m diameter radio telescope used for astronomical observations and for radar measurements.
- An 18-m diameter radio telescope involved in geodetic measurements of the Earth's rotation parameters using very long baseline interferometry (VLBI).
- An 8-station wideband VLBI correlator used to process global geodetic and astronomical observations.
- A 2.5 MW UHF radar that utilizes two large antennas, 46 m and 67 m in diameter, to study the Earth's upper atmosphere using incoherent backscatter techniques.
- An optical observatory consisting of Fabry-Perot interferometers to measure winds in the Earth's upper atmosphere, and a lidar system with the 1.2-m Firepond telescope to measure temperature in the lower atmosphere.

RADIO ASTRONOMY

Haystack Observatory has been pursuing several initiatives associated with the development of large radio arrays for the future that will allow us to achieve very high sensitivity and open new areas of astronomical science. Emphasis has been placed during the past year on the scientific and technical considerations for such arrays, as well as on simulation and configuration studies. As a result, two of these array initiatives have matured to the level that funding will be in place to begin their implementation during the next year.

The first involves a Low Frequency Array (LOFAR) operating at 10–240 MHz using 100 stations distributed over 400 km and connected with optical fiber. LOFAR will allow the detection of radio sources at the milli-Jansky level with arc-second resolution, and will be the first fully digital radio telescope capable of observing with multiple independent beams. In this project led by Dr. Colin Lonsdale, Haystack staff are collaborating with the MIT Physics Department—Professor Jacqueline Hewitt , the Netherlands Foundation for Research in Astronomy, and the Naval Research Laboratory. The scientific projects of interest to the MIT and Haystack astronomers involve measurements of the structure of the universe at the early epoch of re-ionization and the detection of transients such as gamma ray bursts through their radio emission. Based on a successful proposal submitted in the past year to the NSF Information Technology Program, we expect to begin the detailed design of LOFAR starting in October 2001. Construction is expected to start after a three-year design phase which will include evaluation of several candidate sites in the U.S., the Netherlands, and Australia. It is our goal to establish a science center for LOFAR at MIT/Haystack to facilitate the scientific use of the instrument for our research goals as well as for the U.S. astronomical community.

The second array project was proposed by Alan Rogers for the detection of deuterium—a most sensitive indicator of the density of baryons which relates to the assessment of dark matter in the Universe. Detection of the deuterium line at a radio frequency of 327 MHz has been elusive due to inadequate sensitivity of available telescopes. Haystack's proposed approach is through the development of a sensitive digital receiver based on modern technology and the design of an 64-station array of dipole elements to be constructed at the Observatory

in Westford. The proposal competed successfully under the NSF Major Research Instrumentation program, with cost-sharing support from TruePosition, Inc. which supports research at Haystack on the location of E911 calls from cellular phones based on a spin-off from VLBI technology. Prototyping of the antenna and receiver is expected to start in October 2001, with construction to follow in 2003.

Astronomical research work by Haystack staff has concentrated on the application of Very Long Baseline Interferometry (VLBI) at millimeter wavelengths using a global array of twelve radio telescopes to make high resolution observations of radio sources and study their structure and evolution. The significant scientific results that have emerged from this research in the past year included the first polarization images of two Active Galactic Nuclei at 3-mm wavelength, and the measurement of the intrinsic size of the compact source in the center of our galaxy.

VLBI observations of the total intensity and linear polarization of 3C273 and 3C279 at 3-mm wavelength (86 GHz) have been reported by the MIT-Center for Astrophysics post-doctoral researcher at Haystack, Dr. Joanne Attridge. The core of blazar 3C273 was found to be unpolarized while a peak polarization of 11 percent was measured in a jet component adjacent to the core. For blazar 3C279, peak fractional polarization of 26 percent was located between the core and the jet component. These observations revealed the complex magnetic field structures in the core and jets of these two blazars.

A direct measurement of the size of the compact radio source, Sagittarius-A, at the center of our galaxy is important since it helps discriminate amongst different emission mechanisms thought to operate in this source. In the mm-VLBI project led by Drs. Sheperd Doeleman and Alan Rogers, the results indicate a circular size of 0.18 milli-arcseconds for Saggitarius-A, consistent with extrapolations made from observations at longer wavelengths but revealing that we have not yet detected the intrinsic structure of the source as proposed by others. Measurements using longer baselines will continue in the next year with the aim of improving the accuracy of the size determination.

INSTRUMENTATION DEVELOPMENT

The focus of the VLBI instrumentation development in the past year has been on increasing the signal bandwidth in the observations to enhance the sensitivity of our geodetic VLBI systems. The goal is to develop a data acquisition system capable of operating in an unattended mode at a rate of 1 Gbit/sec utilizing commercial off-the-shelf components. Under the leadership of Dr. Alan Whitney, a proof-of-concept demonstration was successfully completed in the past year based on the use of magnetic disks. Initial recording and playback at 0.5 Gb/s were demonstrated at an International VLBI workshop held at Haystack in May 2001 and attended by 75 researchers who are associated with the radio telescopes around the world. All major VLBI groups have endorsed the new Mk5 system due to its reliability and ease of operation. A development path for achieving 1 Gb/s and higher rates has been outlined, and a consortium of funding partners from the national and international community has been assembled to support this work at Haystack Observatory. The plans are to complete the development in 2002 with beta-versions to be released in 2003. Technology transfer to industry will then follow for the implementation of the Mk5 system worldwide.

A key element in the design of the Mk5 system is its ability to interface with high-speed wideband communication links. With the rapid expansion of fiber optic links across the U.S., Europe and Japan, real-time transmission of VLBI data from the radio telescopes to the correlator is now becoming feasible. The advantages of real-time data transmission include the ability to test experimental setups in the field by verifying data acquisition, reduction of delays in processing the data and elimination of tape-shipping costs, and enhanced bandwidth beyond that allowed through data recording. Haystack Observatory has been recently connected with a wideband fiber optic link through efforts at Lincoln Laboratory and MIT, and this allows us to transmit data from the Observatory in Westford to Cambridge, Lexington, and Boston, and then to the Washington D.C. area through DARPA's Bossnet system. This then provides a unique opportunity to begin the development of the real-time VLBI system—named 'e-VLBI' by Dr. Alan Whitney who leads this effort. Work has started on the equipment design for the first demonstration experiment, funded jointly by DARPA and NASA. This involves the acquisition of astronomical data using MIT's Westford radio telescope and the NASA telescope at Goddard Space Flight Center, both of which will be equipped with Mk5 systems, and the transmission of the data through Bossnet to the Haystack correlator for real-time processing. Following a

successful demonstration, we plan to conduct tests with European and Japanese telescopes through the use of Internet2 and equivalent networks.

In a project led by Dr. Alan Rogers and supported by TruePosition, Inc., Haystack participated in field tests of a system aimed at the radio location of E911 calls from cellular phones using VLBI time-delay measurement techniques. The tests successfully demonstrated the accuracy of the system to locate such calls within the specifications set by the FCC in the harsh multipath environment in Manhattan, NY. Current plans call for further research on a system that uses angle-of-arrival measurements to support radio-location in rural areas. Readiness of the TruePosition system for implementation by cellular phone carriers will be determined in October 2001—a date set by the FCC.

ATMOSPHERIC SCIENCE

Major geomagnetic storms occurred during the past year, coincident with the peak in the solar cycle. As a result of two large solar coronal mass ejections July 14, 2000 and March 31, 2001, large perturbations occurred in the Earth's geomagnetic field and in the upper atmosphere and ionosphere, and produced auroral displays as far south as Florida and Texas. The MIT incoherent scatter radars at Haystack Observatory were promptly activated to make observations of the temperature, density, plasma drifts and neutral winds in the region from 100 to 1000 km. Large ion drift velocities and density gradients at 300–400 km altitude were observed by Dr. John Foster and his group during these intense storms, and electric fields of 100 mV/m were detected in the ionosphere—the largest ever recorded at our Observatory. At altitudes near 100 km, the radar observations revealed neutral wind velocities of 500 m/s compared to 50–100 m/s observed during quiet solar times. The winds were found to be northward in direction as a result of heat deposition by the aurora south of our site. These unique data sets form an important input to models of the Earth's upper atmosphere aimed at investigating the coupling between the Sun and Earth—a goal being actively pursued by NSF, NASA and the Air Force Office of Scientific Research.

Using the Rayleigh lidar system that was recently completed at the observatory, significant scientific results were obtained by Dr. Thomas Duck and his colleagues during the past year. The first measurement of a temperature inversion layer at mesospheric altitudes (~50–60 km) in the daytime was recorded, and the first direct evidence of a correlation between the amplitude of the temperature inversion and the intensity of acoustic gravity waves in the stratosphere (below 50 km) was obtained. These unique observations established a causal relationship between the dissipation of gravity waves at their breaking altitudes and the appearance of an inversion layer. The results help improve our understanding of the coupling between the lower and upper parts of the Earth's atmosphere, and fulfill the main goals of the development of the lidar system at the Observatory. The success of the unique daytime observations was achieved by the use of the unique narrow field-of-view 1.2-m Firepond telescope made available to our project by Lincoln Laboratory.

EDUCATIONAL PROGRAMS

The program to strengthen undergraduate education through research in radio astronomy using the MIT facilities at Haystack continued successfully, under the leadership of Dr. Preethi Pratap, the observatory's educational officer. A total of 135 students from 20 colleges within the NEROC consortium and elsewhere have utilized the observatory's 37-m telescope during the past year as part of courses, laboratory exercises and special projects, by either visiting Haystack or controlling the telescope remotely through the internet. An excellent illustration of a project carried out by an undergraduate is that of MIT student Ben Blount who used the telescope to search for radio emission from axions, under the guidance of Professor Leslie Rosenberg of the Physics Department, and recently published his results in the Astrophysical Journal.

Implementation of Haystack's small radio telescope (SRT), which consists of a 2-m antenna with a 1400 MHz receiver, also continued successfully during the past year. The SRT is designed as an introduction to radio astronomy at the undergraduate level. Haystack deployed 18 beta-units of the SRT at various NEROC colleges and other institutions, and the experience gained from these units has been valuable for completing the documentation and improving the operations of the system. Commercialization of the SRT was accomplished during the past year through CASSI—Custom Astronomical Support Services Inc.—a small business formed by Dr. Michael Cobb in southeast Missouri for the purpose of providing copies of our SRT to other interested colleges and groups. At present, Haystack is designing a digital receiver for the SRT to enhance its observational capabilities, and we are testing the usefulness of the SRT at the pre-college levels by working

with high-school science teachers in the local area and making a trailer-mounted telescope available to them and their students.

Finally, Haystack Observatory continued its successful summer research internship program for undergraduates and for pre-college science teachers, with support from the NSF. Eight students recruited from across the nation and four teachers recruited locally have participated in the program during the past year. The students and teachers are mentored by members of the Haystack staff and participate in the Observatory's research projects in astronomy, atmospheric science and instrumentation development. A total of 16 major public outreach activities including two community open-house events were conducted at Haystack during the past year, and about 1000 pre-college students toured the facilities with their teachers as part of our efforts to excite young people about science and engineering.

INFRASTRUCTURE AND ADMINISTRATIVE CHANGES

A new building addition to the Haystack Observatory, consisting of 18 offices and a conference room, was completed in June 2001 to house the Atmospheric Sciences Group. This will provide a better working environment for the staff who were housed in temporary trailers attached to a small building. With the close proximity of the atmospheric and astronomical sciences staff, it is expected that some synergistic interests in common projects such as LOFAR will develop, thus strengthening the overall Observatory research program.

During the past year, the administrative support functions for the MIT facilities at the Westford site have been integrated together under one MIT department—Haystack Observatory. Previously, the budgeting and facility maintenance functions, including support of the Lincoln Laboratory projects in Westford, were carried under two separate departments, Haystack Observatory and Millstone Hill. With the move of the Atmospheric Sciences Group to Haystack and the integration of the Lincoln Laboratory space surveillance activities under a single group, the efficiency and accountability for the entire site administrative support have been enhanced as a result of this integration.

More information about the Haystack Observatory research and education programs can be found online at http://www.haystack.mit.edu/.

Joseph E. Salah

MIT/WHOI JOINT PROGRAM IN OCEANOGRAPHY

The Joint Program of the Woods Hole Oceanographic Institution and the Massachusetts Institute of Technology offers advanced degrees in oceanography and applied ocean science and engineering. Graduate study encompasses virtually all of the basic sciences as they apply to the marine environment: physics, chemistry, geology, geophysics, and biology. Students who choose applied ocean science and engineering may concentrate in the major fields (civil, environmental, mechanical, and electrical), materials science, or oceanographic engineering. More than 160 scientists/faculty from the two institutions participate in the Joint Program. There are currently 107 students enrolled in the five areas of study offered in the program: biological, chemical, and physical oceanography; marine geology and geophysics, and oceanographic engineering.

Since all the MIT faculty involved in the Joint Program are members of an academic department, their individual accomplishments and awards are reported through those departments. These include Courses I, II, VI, VII, XII and XIII.

TITLE OF DEGREES OFFERED BY THE PROGRAM

As part of a campus-wide initiative at MIT to revisit the graduate degree list in terms of specifications of degrees being offered by the various departments and programs, the Joint Program has revised the list of titles of degrees offered by the program. After consultation with the chairs of the five disciplinary committees, the two Joint Program Directors submitted the finalized list to the heads of departments both at Woods Hole and at MIT. If the parties agree with the proposed modifications, the list will then be forwarded to the Dean for Graduate Students for MIT approval.

CURRICULUM MODIFICATIONS

The description of the curriculum in physical oceanography has been updated to reflect the variety of tracks which students can pursue within their course of study. Formally identifying these tracks was found to be helpful not only to current students in physical oceanography, but to those applying to the program.

The curriculum in marine geology and geophysics, chemical oceanography, and physical oceanography is currently being revisited in order to address new areas of concentration such as paleoclimate, paleoceanography, climate studies and geochemistry. The general exam structure is also being reviewed so that it may be more consistently applied across the various disciplines.

STUDENT APARTMENT AT 100 MEMORIAL DRIVE

After receiving many requests for a furnished apartment for students who commute regularly from Woods Hole to Cambridge and who need a temporary place to stay on campus, the Joint Program rented a unit at 100 Memorial Drive for one year as an experiment. This experiment proved to be a success and the apartment has now become a permanent feature of the program at MIT.

More information about this program can be found online at http://web.mit.edu/mit-whoi/www/.

Paola Rizzoli, Ronni Schwartz

NUCLEAR REACTOR LABORATORY

The Nuclear Reactor Laboratory (NRL) is an interdepartmental center that operates a 5 MW research reactor in support of MIT's educational and research missions. This reactor, which is designated as the MITR, is a heavy-water reflected, light-water cooled and moderated nuclear reactor that utilizes flat, plate-type, finned, aluminum-clad fuel elements. The average core power density is about 70 kW per liter. The maximum thermal neutron flux available to experimenters is 5×10^{13} neutrons/cm^{2}s. The reactor is the NRL's principal experimental facility.

The past year has been a very active one for the NRL. The relicensing of the MITR with a concomitant upgrade in power is in progress. The Nuclear Regulatory Commission (NRC) has authorized the continued operation of the MITR pending its review of the application that was filed in 1999. That process remains ongoing. In conjunction with the relicensing effort, reactor systems are being upgraded. Upgrades to electrical distribution systems were initiated in 2000. New control blades and control blade drives will be installed in 2001. In addition, in order to support the future of the MITR and university research reactors in general, John A. Bernard, Director of the MITR, worked closely with members of the MIT Administration, the U.S. Department of Energy (DOE), and the university research reactor community. As a result of these actions, additional funding has been promised to the MIT Administration by the DOE in support of the MITR and certain government funding options are being established as a means of strengthening university research reactor programs around the United States.

There were also several especially noteworthy developments concerning the continued program in joint research with Beth Israel-Deaconess Medical Center (BIDMC) on the treatment of cancer utilizing the boron neutron capture method during the past year. These include the characterization of the Fission Converter Epithermal Beam Medical Facility which is now ready for BNCT Clinical Trials. After more than a decade of research, design, and construction, MIT now has the best epithermal beam for neutron capture therapy in the world. Major initiatives were undertaken last year by both BIDMC and the MIT Staff to explore funding opportunities through the National Institutes of Health (NIH), and the National Cancer Institute (NCI) as well as other sources. This initiative included several grant proposals that were submitted to NIH and NCI. As a result of these efforts, funding for a phase I/II study of tumor response and normal brain was approved by the NIH. The DOE, which funded the fission converter beam and facility, has also indicated that it will cover MIT costs (labor and neutron charges) related to BNCT trials. It is anticipated that the NIH will also fund a phase II study on melanoma of the extremities.

As in past years, the NRL continued its joint interdisciplinary activities with both MIT and non-MIT collaborators, including academic departments and interdepartmental laboratories and a number of other universities, schools, and nonprofit research institutions such as teaching hospitals. These joint research or teaching and training activities cover a wide spectrum in the life and physical sciences and in engineering, including development of cancer therapy, nuclear engineering, computer control of reactors, training in reactor operations, dose reduction and materials performance in power reactors, radiochemistry and trace analysis applied to the health effects from energy use, nutrition, earth and planetary sciences, environmental studies, and nuclear medicine.

NEUTRON BEAM TUBE RESEARCH

The prompt gamma neutron activation analysis facility was used both for research and in support of the neutron capture therapy clinical trials.

ENVIRONMENTAL RESEARCH AND RADIOCHEMISTRY

Professor Frederick A. Frey, Department of Earth, Atmospheric and Planetary Sciences, and Dr. Pillalamarri Ila supervise operation of the Neutron Activation Analysis Laboratory which is part of the Center for Geochemical Analysis within the Earth, Atmospheric and Planetary Sciences Department. Trace element abundances are determined in a wide range of natural materials. Currently the laboratory is focused on analyses of volcanic rocks recovered during the ongoing Hawaiian Scientific Drilling Project and the recently completed Leg 183 of the Ocean Drilling program which focused on sampling the very large igneous province that forms the Kerguelen Plateau.

The NRL also operates its own Trace Analysis Laboratory and made its neutron activation analysis (NAA) facilities and expertise available to industry, other universities, private and governmental laboratories, and hospitals. Research and/or service-oriented collaborations were continued with several MIT research laboratories as well as with other

educational and research institutions including: Harvard, California Institute of Technology, Tufts University, University of Utah, University of Connecticut, and the Woods Hole Oceanographic Institute.

Within MIT, research support has been provided to several departments. This research support includes analysis of various environmental and biological samples for trace and toxic metals for Professor William G. Thilly (Center for Environmental Health Sciences) as well as for faculty in both the Department of Civil and Environmental Engineering and the Department of Chemical Engineering.

A number of other research applications of NAA are summarized in a subsequent section, Reactor Irradiations for Research Groups outside MIT.

NUCLEAR MEDICINE

A fission converter based epithermal neutron beam irradiation facility for BNCT was constructed over a period of 2.5 years and was successfully put into operation during this year. The intensity of this beam has been measured and it is the highest intensity beam available anywhere in the world. The beam quality has also been experimentally verified and it is of near theoretical purity. Irradiation times will be as short as a few minutes and therapeutic ratios (dose to tumor/dose to normal tissue) will be 4–5, a doubling over the therapeutic ratio available with the previous MIT epithermal neutron beam. In addition, the Fission Converter Epithermal Neutron Beam Medical Facility was also completed. This facility is now available and will provide a high intensity and high purity epithermal neutron beam for BNCT irradiations of human cancers. This new facility will be the key component in future clinical tests of the efficacy of BNCT for cancer. It will also assure that MIT will maintain its leadership role in this research area.

A contract has been continued with the DOE for the reconstruction of the medical irradiation beam in the basement of the MITR. When completed this facility will provide a high intensity and high purity thermal neutron beam for BNCT irradiations of small animals and superficial human cancers.

BNCT research at the MIT Research Reactor is under the direction of Professor Otto K. Harling and is carried out in collaboration with the medical staff at the Beth Israel-Deaconess Medical Center. Several MIT graduate students are completing their theses on these projects.

RADIATION HEALTH PHYSICS

The NRL supports a subdiscipline in the Nuclear Engineering Department (NED), Radiation Health Physics, by providing relevant research opportunities. The NRL also contributes to a specially designed laboratory and demonstration course. This course, 22.09/22.104, Principles of Nuclear Radiation Measurement and Protection, is appropriate for all students in NED. Research topics and support for health physics students were provided by NRL projects, especially the BNCT and Dose Reduction projects of Professor Otto K. Harling.

Dr. John A. Bernard, who is certified as a Health Physicist by the American Board of Health Physics, continued to teach course 22.581, Introduction to Health Physics. This course uses the MIT Research Reactor to provide practical examples of health physics issues.

IN-CORE MATERIALS STUDIES

A new in-core autoclave facility was successfully built to study the effect of radiation on candidate ceramic clads. The benefit to the use of such clads is the elimination of the potential for a steam-zircaloy reaction that now exists with the zirconium-based clads that are currently in use. The program was funded by Gamma Engineering Corporation under a DOE Nuclear Engineering Research Initiative Grant.

An in-core loop to study the causes of "shadow corrosion" is now being designed and installation is expected late in 2001.

REACTOR ENGINEERING

Dr. Bernard continued to teach course 22.921 Reactor Dynamics and Control and to offer review classes on engineering fundamentals for NED students in the radiological sciences. Both activities make use of the reactor for illustrating theoretical concepts. The program on the digital control of nuclear reactors continued with thesis activity in the area of automated diagnostics. One student completed a Ph.D. in this area during the past year.

MITR RELICENSING AND REDESIGN

The relicensing of the MITR with a concomitant upgrade in power is in progress. It was previously identified that the MITR could operate at a maximum power of 6–7 MW with the existing heat removal equipment. A decision was subsequently made to submit the licensing documents for a power increase from 5 MW to 6 MW. On July 8, 1999, a formal application was submitted to the U.S. Nuclear Regulatory Commission (NRC) to relicense the reactor for an additional twenty years and to upgrade the power level to 6 MW. The relicensing package included a complete rewrite of the Safety Analysis Report and the Technical Specifications. The NRC has authorized the continued operation of the MITR pending its review of the application. That process remains ongoing. In conjunction with the relicensing effort, reactor systems are being upgraded. Upgrades to electrical distribution systems were initiated in 2000.

REACTOR IRRADIATIONS FOR GROUPS OUTSIDE MIT

In nuclear medicine, the development and/or continuing production of radioisotopes for use by researchers at hospitals and other universities included investigations using track etching techniques by Dr. David Slaughter of the University of Utah to determine the uptake pattern of heavy metals by humans as well as the environment, and evaluation of copper and gold for arthritis treatments by Dr. Alan B. Packard of Children's Hospital.

In a number of other areas reactor irradiations and services were also performed for research groups outside MIT. Most of these represent continuations of previous research. Examples include Dr. Alan P. Fleer of Woods Hole Oceanographic Institute who used irradiation to determine natural actinides and plutonium in marine sediments and Dr. Rebecca Chamberlain of the Los Alamos National Laboratory who is investigating calibration of ultra-sensitive neutron monitoring devices by thermal neutron fission of uranium foils, as well as isotope production for cardiovascular research by both Best Industries, Inc. (Springfield, VA) and Implant Sciences (Wakefield, MA).

Whereas most of the outside users pay for irradiation services at the reactor, educational institutions needing such services for their own academic or research purposes are assisted in this regard by the DOE through its "Reactor Sharing Program." A grant to MIT NRL reimburses us for the costs of providing irradiation services and facilities to other not-for-profit institutions (including teaching hospitals and middle and high schools). Under this program, 500 students and 50 faculty and staff from over 30 other educational institutions benefited from visits to and use of the MITR during the past year.

Research utilization of the MITR by other institutions under the Reactor Sharing Program during the past year has included: use by Professors J. Christopher Hepburn and Rudolph Hon of Boston College to activate geological specimens and standards for the neutron activation analysis of rare earth and other trace elements in studies of the geological development of the northeastern United States; irradiation of coal ash samples for research being conducted by Professor JoAnne Lighty at the University of Utah, gamma irradiation of plant seeds for several area high school students participating in science fair projects; measurements of boron concentration and work on high resolution track etch autoradiography for Professor Robert Zamenhof of Beth Israel - Deaconess Medical Center; participation in several special high school student projects; neutron activation analysis of subsurface water supplies by Professor Jack Beal at Fairfield University; neutron time-of-flight and Bragg angle measurements by Professor Martin Posner's group at the University of Massachusetts; NaOH irradiation for Professor Clayton French of UMass-Lowell; and use of neutron activation analysis for Bromine measurements by Professor Joseph Kehayias (Tufts) and Senior Research Scientist Richard Lanza (MIT NED) to evaluate intra/extra-cellular water as an indicator of overall human health.

For education of the general public and students at all levels in local and other New England schools, the reactor staff provides lectures and tours periodically throughout the year.

MAJOR REACTOR SERVICES

The MITR produces about $1.2 million worth of neutron transmutation doped (NTD) silicon per year. This is commercial income and the funds are used to offset operating costs. The market for NTD silicon remains strong despite improvements in the chemical production of the material. At present, demand exceeds the MITR's capacity. A major project to neutron transmutation dope semiconductor grade silicon single crystals continued for a successful eighth year. Approximately 10 metric tons of Si crystals were accurately irradiated in shielded, automated irradiation facilities at the MITR. This project is under the technical direction of Professor Otto K. Harling.

AFFIRMATIVE ACTION

The NRL supports the affirmative action goals of the Massachusetts Institute of Technology. Of a staff of 37 there are currently five engineering and management positions held by minorities and women. The NRL participated in the U.S. DOE's program for minority training in reactor operations, and one of our current senior reactor operators is a graduate of this program.

MIT RESEARCH REACTOR

The MIT Reactor completed its 43rd year of operation, its 27th since the 1974–75 shutdown for upgrading and overhaul. The reactor operated continuously (seven days per week) to support major experiments. On average, the MIT Reactor was operated 134 hours per week at its design power level of 5 MW. Energy output for the MITR-II, as the upgraded reactor is now called, totaled 512,000 megawatt-hours as of June 30, 2001. The MITR-I generated 250,445 MW in the sixteen years from 1958 to 1974.

The senior reactor staff continued to be active in the nuclear field. Dr. Bernard completed his term on the Board of Directors of the American Nuclear Society (ANS) and Dr. Hu was elected Chair of the Isotopes and Radiation Division of ANS with her term scheduled to start in June 2002.

To summarize briefly the reactor was well utilized during the year, although still more experiments and irradiations can be accommodated because of the number and versatility of the many experimental facilities. The number of specimen irradiations was 370. There were 78 irradiations in the medical rooms, many in support of the neutron capture therapy program for the treatment of brain cancer and subcutaneous melanoma. Theses and publications on research supported by the reactor are running at about 5 and 20 per year, respectively. A total of 1172 people toured the MIT Research Reactor from July 1, 2000 through June 30, 2001.

John A. Bernard

OPERATIONS RESEARCH CENTER

The Operations Research Center (ORC), established in 1953 as a first-of-a-kind interdepartmental graduate degree program, completed its 48th year of operation in 2000–2001. The center administers its own graduate programs and a varied research program of methodological and applied projects. It maintains a reading room with a small library, as well as state-of-the art computational workstations.

This report summarizes the center's 2000–2001 activities and briefly reviews its educational, research and outreach programs.

FACULTY, STUDENTS, AND STAFF

Professor James B. Orlin, Edward Pennell Brooks Professor of Operations Research and Cynthia Barnhart, Associate Professor of Civil and Environmental Engineering served as codirectors during 2000–2001.

This year the ORC had 44 affiliated faculty and senior staff, with faculty drawn from the School of Management and the Departments of Electrical Engineering and Computer Science, Civil and Environmental Engineering, Ocean Engineering, Mathematics, Aeronautics and Astronautics, Mechanical Engineering, Nuclear Engineering, and Urban Studies and Planning.

The Operations Research Center offers two interdepartmental graduate degree programs, a Ph.D. and a master's degree. During 2000–2001, these programs enrolled 49 students—36 Ph.D. candidates, 11 S.M. candidates and two special students. In addition, this year we hosted three visiting students. The center conferred 11 master's degrees and three Ph.D.s. Several other Ph.D. theses were in the final stages of completion in the summer of 2001.

ACADEMIC PROGRAMS

The ORC's academic programs continue to be recognized as ranking among the very best nationally and internationally. The program, moreover, is repeatedly cited as achieving an excellent balance between application and methodological domains.

RESEARCH ACTIVITIES

Research activities spanned a wide spectrum of methodological topics and applications, ranging from small, unsponsored projects involving a single faculty supervising a student's thesis, to much larger sponsored programs involving several faculty/staff and students.

Methodological research includes such topics as linear, nonlinear, and combinatorial optimization, solution methods for integer programming, interior point methods for linear and nonlinear programming; cluster analysis; parallel and distributed computation and algorithms; network flow algorithms; network design; probabilistic combinatorial optimization; deterministic and stochastic facility location; queueing theory, including queueing networks; risk analysis, stochastic processes; classical and Bayesian statistics; and decision analysis and statistical decision theory.

ORC faculty are also currently contributing to application domains as wide ranging as manufacturing, communications, transportation, public services, logistics, marketing, financial services, health care, and nuclear engineering. Current projects are addressing such topics as air traffic control, epidemiology, AIDS testing, life-cycle modeling of municipal solid waste, safety and risk analysis in air transportation, telecommunication network design, supply chain management, production scheduling, and transportation logistics.

Several organizations sponsored research projects at the ORC during 2000–2001, for example: the National Science Foundation; C.S. Draper Laboratory (several projects and Draper Fellowships); CSX Transportation Inc.; General Motors; Federal Aviation Administration's Center of Excellence for Aviation Operations Research; Logistics Management Institute; Office of Naval Research; Singapore/MIT Alliance Program; and United Airlines.

OUTREACH AND PROFESSIONAL SERVICE

In its effort to serve the professional community at large, the ORC regularly undertakes a number of outreach activities.

Professor Amedeo R. Odoni and Richard de Neufville offered a professional course in October of 2000: "Airport Systems: Strategic Planning and Detailed Design."

The Engineering Systems Division and the Operations Research Center, in conjunction with IBM and General Motors, organized the "First East-Coast Round Table in Operations Research." The conference brought together students, faculty and researchers from nearby leading institutes for a day of presentations and discussions on work in a common research area. This year the focus was on Operations Research Models in E-Commerce. Professor David Simchi-Levi served as the Faculty Coordinator and Amy Cohn, Sanne de Boer and Damian Beil (OR doctoral students) served as the Student Coordinators.

The ORC Seminar Series was privileged to have many distinguished speakers from industry and academia this year. Among the many operations research professionals who made presentations were: Christos Papadimitriou (Univ of CA/Berkeley); Markos Papageorgiou (Tech Univ of Crete); L.D. Servi (GTE Labs); Steve Wright (Argonne Natl Lab); M. Elisabeth Pate-Cornell (Stanford); Anton Kleywegt (GA Inst of Tech); Lisa Fleischer (Carnegie-Mellon); Daniel Bienstock (Columbia); Madhu Sudan (MIT); Michael Todd (Cornell); Stefanos Zenios (Stanford); Richard Sutton (AT&T Bell Labs); Rakesh Vohra (Northwestern); and Donald Hearn (Univ of FL).

The center also offered a program of activities during the January independent activities period, including a series of presentations on the practice of operations research and management science presented by Michael Clarke (Sabre); Rina Schneur (Verizon Laboratories); Jeremie Gallien (Neoptis, Inc); and Sebastian Ceria (Axioma).

During 1999–2000, the Operations Research conducted both an Internal and External Strategic Review of the OR programs. Based on the feedback received from the reviews, during the academic year 2000–2001 we focused on the evaluation and the implementation of some of these recommendations.

- M.Eng. in OR—The OR Center is exploring a program in computational design and optimization.
- Student Quality of Life—We worked to improve the "quality of life" for OR students by modifying the existing exam format for the qualifying exam; modifying current procedures and guidelines for the thesis proposal/defense; starting monthly meetings with co-directors and students to talk about issues at the OR Center; and by installing a wireless network; purchasing numerous computational workstations; upgrading software and purchasing new software.
- Probability/Statistics Classes—A few OR-affiliated faculty members served on a statistics review committee. The end result was a report to ESD which will likely guide the hiring of statistics faculty in Engineering over the next few years.
- OR web site Redesign—enhancements made to the website include redesign of homepage; ORC Open House; and interviews with a few current graduate students. During the upcoming year, the OR Center intends to expand the web site. Some future endeavors will be: addition of faculty publications/research papers; expansion of student and faculty homepages; and addition of a page for perspective students in OR.

DIVERSITY

The ORC has always attempted to provide an environment that is responsive to the varied professional and personal needs of the OR community at MIT, and that builds upon diversity.

The ORC makes no faculty appointments. The staff of the ORC is composed of two support staff members and one administrative officer. Of these three staff, all are women, and two are African-American.

During the past year, the Operations Research Center continued to strive to increase the diversity of its graduate student population. A promotional email about the OR Center and its programs was sent to a selected number of math departments at historically black colleges and universities. Similar email messages were sent to all of our alumni who currently hold academic positions throughout the country, and to selected Ivy League universities in an attempt to attract women and minorities to the OR program at MIT. We are happy to report that we were extremely successful in our recruitment efforts as evidenced by an increase of 50 percent in applications received from female candidates. For the upcoming academic year, we expect a 67 percent increase in the female population of the OR programs.

PROFESSIONAL ACTIVITIES

Arnie Barnett was selected by the Operational Research Society of the UK to give the year 2000 Blackett Memorial Lecture (in honor of Lord Blackett, the advisor to Churchill who made "the slide rule more potent than the torpedo" during World War II). The event took place in November 2000 at the Royal Aeronautical Society in London. Richard de Neufville was named a Class of 1960 Fellow. In addition, Richard was the Distinguished Visitor at the University of Calgary, Canada. Robert Freund received an Award for Excellence in Teaching at the MIT Sloan School of Management. Jeremie Gallien, an OR alumni, won the INFORMS MSOM Society student paper award. Soulaymane Kachani, an OR doctoral student, was the recipient of the Karl Taylor Compton Prize. This award is presented to students in recognition of their outstanding contributions in promoting high standards of achievement and good citizenship within the MIT community. John Little was the Omega Rho Distinguished Lecturer for 2000. He delivered the plenary address at the INFORMS Conference in San Antonio. Also, John was presented the INFORMS Expository Writing Award. Thomas Magnanti was awarded the Irwin Sizer Award for the most significant improvement in MIT Education. This award is presented to any member or group in the Institute community to honor significant innovations and improvements in MIT education. Georgia Perakis was awarded the Presidential Early Career Awards for Scientists and Engineers (PECASE) at the White House. Also, Georgia received the Charles Reed Faculty Initiative Award from MIT. This award is given to faculty for developing innovative research. In addition, Georgia received the University Transportation Research Award. David Simchi-Levi was awarded the Outstanding IEE Publication Prize and the IEE Joint Publishers Book-of-the-Year Prize by the Institute of Industrial Engineers for his book "Designing and Managing Supply Chain: Concepts, Strategies and Case Studies," coauthored with P. Kaminsky and E. Simchi-Levi. In addition, David was awarded the Outstanding First Edition of the Year Prize by McGraw-Hill/Irwin.

More information about the Operations Research Center can be found online at http://web.mit.edu/orc/www/.

Cynthia Barnhart, James B. Orlin

PLASMA SCIENCE AND FUSION CENTER

MIT's Plasma Science and Fusion Center (PSFC) is recognized internationally as a leading laboratory in developing the scientific and engineering aspects of magnetic confinement fusion and conducting cutting-edge research in plasma science and related technology. Research at the PSFC is carried out in 5 primary areas: fusion energy confinement research in the Alcator C-Mod tokamak, including investigations of the stability, heating, and transport properties of high temperature magnetically confined plasmas, as well as advanced tokamak research (AT); investigation of the basic physics of plasmas including magnetic reconnection experiments on the VTF facility, new confinement concepts such as the Levitated Dipole Experiment (LDX), development of novel high-temperature plasma diagnostics, novel diagnostic of inertial fusion experiments, basic laboratory and ionospheric plasma physics experiments, and theoretical research; a broad program in fusion technology and engineering development that addresses problems in several areas (e.g., magnetic systems, superconducting materials, fusion environmental and safety studies, and system studies of fusion reactors); a significant activity in developing environmental remediation techniques based on plasma technology, including industrial applications, and the physics of waves and beams (gyrotron and high gradient accelerator research, beam theory development, non-neutral plasmas, and coherent wave generation).

The PSFC R&D programs are supported principally by the Department of Energy's Office of Fusion Energy Sciences. There are approximately 245 personnel associated with PSFC research activities. These include: 18 faculty and senior academic staff, 48 graduate students and 7 undergraduates, with participating faculty and students from Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Physics; 62 research scientists, engineers and technical staff, 58 visiting scientists and engineers, postdoctoral associates and research affiliates, 30 technical support personnel; and 22 administrative and support staff.

PSFC's research funding for FY2001 totaled $25.9-million, down slightly (1.4 percent) from $26.2-million in FY2000. Nearly 84 percent of the FY2001 total came from one sponsor—the Department of Energy's Office of Fusion Energy Sciences (OFES). Based in part on preliminary projections, we estimate that total funding in FY2002 will increase to $26.5-million. OFES funding in FY2002 is expected to decline by 3.8 percent relative to FY2001 (from $21.7million to $20.8million), but non-OFES related funding at the Center will increase by 35 percent during that same time period (from $4.2-million to $5.7million). The 35 percent increase in non-fusion related work is due in large part to an increase in funding from private industry in FY2002. These estimates are based on the U.S. Government's fiscal year which begins October 1.

An external visiting committee consisting of prominent members of the U.S. plasma science and fusion community met at MIT September 18–19, 2000 with the PSFC director, division heads, technical staff and graduate students to assess the overall state of research at the PSFC. In its summary report to MIT's Provost, Chancellor and Vice President for Research, the committee noted that "For several decades, the MIT plasma (science) and fusion effort has been one of international prominence. We are pleased to report that this world-class excellence continues today under the present center leadership, with the superb staff of scientists and engineers, and with unique experimental facilities. In essentially all major areas of its chosen research, the center is at the forefront internationally. MIT is to be commended for the foresight in developing the center and for its continuing support." The report went on to note that the decline in faculty count and the relative seniority of current PSFC-affiliated faculty are perhaps the most important issues facing the center at this time. The committee warned of a possible decline in prominence of the center if faculty staffing issues are not addressed in the near future.

ALCATOR DIVISION

The Alcator Project, led by Professor Ian Hutchinson and Dr. Earl Marmar, carries out experimental research on Alcator C-Mod, a compact, high-field high-performance divertor tokamak devoted to investigating the physics of high temperature magnetically confined fusion grade plasmas. The total staff of the Alcator Project is about 100. Two major collaborations, with the Princeton Plasma Physics Laboratory (PPPL) and the University of Texas at Austin continue to play important roles in the research program, and a large number of smaller collaborations with other institutions, both domestic and international, are also active collaborators in scientific research.

Experiments devoted to all of the major research topics on C-Mod were carried out during the twelve month period ending August, 2001, including Core Transport, Pedestal (edge) Physics, ICRF physics and development, high performance operations, and Divertor/SOL physics. Research into core transport and stability was concentrated on extending our understanding of double barrier discharges, which exhibit a core internal transport barrier with an H-mode (High Confinement) edge. The core barriers are reliably triggered by the application of off-axis ICRF heating, with the resonance located on the high-field side of the plasma. During the winter run period, we took advantage of our capability to operate 50 percent of our RF systems at tunable frequencies, so that the ITB could be triggered with the off-axis heating at one frequency while the core of the plasma, inside the barrier, could be heated at a different frequency. These experiments were started in December 2000, and continued in July 2001. A number of interesting physics results were obtained, and at present these phenomena are being analyzed with transport models and codes. Another significant result obtained in the July experiments was that the ITB could also be triggered with off-axis heating on the low field side; this result has important implications in regard to theoretical interpretation of these results.

Studies of the dynamics of the H-Mode edge pedestal were continued during the past year, with a strong emphasis on detailed, high spatial resolution diagnostic measurements in this region of the plasma. With increased total RF heating, and the achievement of high pressure gradients in the edge, small high frequency Edge Localized Modes (ELMs) appear in the pedestal region, on top of the quasi-coherent (QC) fluctuations (reported last year) which appear to control particle transport across the barrier region in the Enhanced D-alpha (EDA) H-Mode. In some cases, the QC mode appears to weaken, and the ELMing activity may take over as the arbiter of particle transport. In a related set of experiments, edge similarity studies, coordinated between C-Mod and the DIII-D tokamak in San Diego, obtained excellent comparison discharges, and the results indicate that the edge pedestal dynamics are probably dominated by plasma physics effects rather than atomic physics processes. In a new diagnostic effort, high speed imaging of edge fluctuations has revealed the time history dynamics of the small poloidal scale turbulence that is believed to dominate the transport (particularly for particles) in the region near to and outside (open field lines) of the separatrix. The images provide time history visualization of the structures, with resolution down to the microsecond range, and should lead to a significant increase of understanding of this important physical process, particularly through detailed comparison with numerical simulation.

At the end of the campaign, we carried out a set of experiments on long-pulse operation, primarily in preparation for the Lower Hybrid current drive, Advanced Tokamak investigations which will begin in FY2003. Inductively driven plasmas were investigated with total pulse length reaching 3.2 seconds. Physics experiments on these plasmas included investigations into divertor power loading and wall pumping/recycling evolution over the long pulse times.

A significant fraction of the project effort in the past 12 months has been devoted to modifying and improving the 4 strap (J-port) ICRF antenna. Substantial rework of the antenna was carried out in the period from January to April 2001, including a redesign of the feed straps located behind the antenna, to reorient them so that the RF electric fields are perpendicular to the magnetic field imposed by the tokamak coils and plasma current. In addition, changes were made to the plasma facing structures, to reduce the effects of RF-plasma interactions. These changes were highly successful, and allowed for substantial increases in the power levels which could be reliably coupled through the antenna to the plasma.

Beginning on August 6, the C-Mod facility entered an extended maintenance, inspection and upgrade period. During the next eight months, the TF magnet joints will be inspected, as was recommended by an engineering review panel. The inner divertor structure, and a portion of the inner wall tile support structure, is being replaced during this time. These inner wall changes will open up the space for shaping, particularly with regard to increased triangularity for lower X-point single null configurations, and at the same time will increase the strength of the structures, to allow for operation up to plasma currents of 2 MA.

PHYSICS RESEACH DIVISION

The Physics Research Division, headed by Professor Miklos Porkolab, seeks to develop a theoretical and experimental understanding of plasma physics and fusion science. This division is also a base for developing basic plasma physics experiments, new confinement concepts, novel inertial confinement fusion diagnostics and space plasma physics experiments. In addition, this division is also the home for a strong base and supporting theory program.

FUSION THEORY AND COMPUTATIONS

Plasma Edge and Core Transport and Turbulence Theory

This group (Drs. P. Catto, J. Ramos and A. Simakov, and Mr. J. Hastie) studies the physics of turbulence, transport and stability related to plasma confinement experiments. The research relies on analytic investigations with numerical support aimed at understanding experimental observations from Alcator C-Mod and other tokamaks. It also includes theoretical support for the Levitated Dipole Experiment (LDX) being built at the PSFC in collaboration with Columbia University. Our research efforts this past year have focused on the following four key areas: a detailed proof that the induced electric field in C-Mod and other tokamaks is responsible for an additional poloidal plasma flow because of the presence of particles trapped in the magnetic field; a detailed evaluation and demonstration that the electric field just inside the separatrix of C-Mod and other tokamaks is set by the neutral viscosity for realistic neutral mean free paths, and that the neutrals can impact the poloidal flow of the ions; theoretical studies of global magnetohydrodynamic modes and the important edge localized Quasi Coherent Mode instability responsible for a benevolent regime of confinement in C-Mod; and a complete determination of the weakly collisional, long mean free path stability conditions for an equilibrium of arbitrarily high pressure plasma confined in a dipole magnetic field similar to that expected in LDX.

Advanced Tokamak Physics, MHD Stability, and RF Interactions

There have been four main thrusts to the work (of Drs. P. Bonoli, J. Ramos and M. Porkolab and Mr. J. Hastie) in this area in the past year.

- A study of mode conversion processes from the long wavelength magnetosonic (fast Alfvén wave) into short wavelength kinetic ion Bernstein waves in toroidal geometry using a full-wave electromagnetic field solver showed good agreement with experimental observations on C-Mod. Efforts are now underway to implement the field solver on a massively parallel platform under a new grant obtained through the Office of Fusion Energy Science.

- A generalization of the ballooning formalism to the analysis of high-toroidal-number, edge-localized external modes led to an analytic understanding of the instability range and growth rate of the "peeling" mode, which previously could only be obtained with two-dimensional codes.
- A two-fluid analytic model to investigate driven magnetic reconnection in collisionless or semi-collisional plasmas was developed which can describe the evolution of current layers and fast reconnection rates in the VTF experiment at the PSFC.
- A theory of electrostatic drift waves in a closed field line configuration such as the LDX experiment was developed which allows for a transition from collisional to collisionless regimes. The form of the stability boundary remains qualitatively unchanged, but the stable region narrows somewhat as the plasma collisionality is reduced.

RF Heating and Current Drive and Basic Plasma Theory

This effort, led by Professor A. Bers and Dr. A. Ram, obtained the following results:

- Derived symmetry relations during mode conversion processes based solely upon energy flow conservation and Onsager-like time reversibility properties of the full wave description of the fields. These symmetry relations show that emission from thermal electron Bernstein waves (EBWs) can be used to find optimal plasma edge conditions which will maximize the excitation of EBWs, from power sources external to the plasma, for plasma heating and current drive in high-beta tokamaks such as the Princeton NSTX experiment.
- On synergism in RF driven current with the bootstrap current—a problem of importance to the steady state operation of a tokamak confined plasma—an improved code for solving the drift kinetic Fokker-Planck equation with quasi-linear and neoclassical effects has been generated in collaboration with Dr. Y. Peysson of the CEA in Cadarache, France. Synergism is found in both lower hybrid and electron cyclotron driven currents.
- In relation to intense laser-plasma interactions of importance to inertial confinement fusion (ICF), graduate student Ron Focia, in collaboration with the ICF group at the Los Alamos National Laboratory, carried out a unique set of laser-plasma experiments in a single laser hot spot. The experiments showed unequivocally, and for the first time, the coupling of stimulated Raman scatter to the Langmuir decay instability with cascades, and a new type of electron acoustic wave. Analytical and computational studies have been undertaken to understand these results.

PLASMA PHYSICS EXPERIMENTS

Levitated Dipole Experiment

The Levitated Dipole Experiment (LDX) represents a new concept exploration experiment sponsored by the Department of Energy and is initially funded as a five year research grant. LDX is a joint collaborative project with Columbia University and is located in Building NW21 at MIT. The principal investigators of this project are Dr. Jay Kesner of the MIT and Professor Michael Mauel of Columbia University. The LDX facility is being designed by the engineering division of the PSFC under the leadership of Dr. J. Minervini.

The levitated dipole experiment represents a new and innovative approach to magnetic fusion which will utilize a levitated superconducting coil to confine plasma in a dipole magnetic field. The concept was inspired by the observation that high pressure plasmas can be confined by planetary dipole magnetic fields, such as the magnetosphere which surrounds Jupiter. Compared with the traditional fusion approaches the levitated dipole may permit the confinement of higher pressure plasmas with reduced cross-field transport. The project has been funded as a five year grant with an approximate annual budget of $1.4 million, (shared between MIT and Columbia University). The construction of the project will take approximately four and a half years.

The design of the facility was largely completed during FY1998 and we are now nearing the end of the construction phase. The vacuum chamber is in place in the Tara cell of Building NW21, the high performance Nb3Sn floating coil has been successfully tested and is being installed within a cryostat and the high temperature superconducting levitation coil is under construction. Unfortunately, the startup of the experimental program has been delayed to the latter part of CY2002 due to a one year delay in the delivery of a large "charging" coil from Russia. When completed, LDX will be the only superconducting magnetic confinement experiment in the U.S. fusion research program.

Magnetic Reconnection Experiments on the Versatile Toroidal Facility (VTF)

Magnetic reconnection plays a fundamental role in plasma configurations because magnetic energy can only be released if the magnetic field line topology is changed. It controls the spatial and temporal evolution of explosive phenomena such as solar flares, corona mass ejections and internal disruptions in magnetic fusion devices. The basic plasma experiment led by Professor A. Fasoli and Dr. J. Egedal is now fully operational for the study of magnetic reconnection. Typically, 500 experimental plasma discharges are created per day when the VTF is operated. Due to the high reproducibility of the radio frequency (RF) generated plasmas it has been possible to measure the plasma response to reconnection with unprecedented accuracy. During driven reconnection events the collisionless plasma is characterized in terms of space and time evolution of magnetic fields, currents, density and electric potential. These experimental results have stimulated the development of new theoretical models for reconnection which will be tested experimentally in the near future.

MIT-PSFC/JET Collaboration on Alfvén Wave Instabilities

The MIT-JET collaboration is aimed at studying the interaction between non-thermal plasma particles and electromagnetic waves in the Alfvén range of frequencies on the JET tokamak. The interaction between plasma waves and fast particles such as fusion produced alphas is one of the critical issues to understand the behavior of burning tokamak plasma and can be studied on the reactor-relevant JET plasmas. During the last experimental campaigns on JET, a number of dedicated experiments have been performed and have led to significant progress in the understanding of the possible stabilization mechanisms of Alfvén Eigenmodes. These results have contributed to improving the theoretical understanding of the physics of the interaction between high energy particles (such as alpha particles) and Alfvén waves in thermonuclear fusion plasmas. In addition, a project for the development of new dedicated antennas for the excitation of electromagnetic waves has been prepared and has been presented to the relevant EFDA-JET Committee, receiving a very favorable assessment.

Inertial Confinement Fusion Experiments

MIT's effort in inertial confinement fusion, led by Dr. Richard Petrasso, is a collaboration with the University of Rochester and Lawrence Livermore National Laboratory. This program has continued to produce exciting results on experiments conducted at the OMEGA laser facility at the Laboratory for Laser Energetics at the University of Rochester. MIT has been responsible for designing and implementing two very large charged-particle spectrometers, and nine smaller ones.

Such spectrometers are used to detect charged fusion products that are generated at the core of imploding ICF capsules. From the number of such reactants (i.e. the yield), the effectiveness of the fusion process can be determined, and from the energy loss of the reactants, as they pass through the capsule, a measure of the capsule compression can be determined. Both these quantities, yield and capsule compression, are fundamental parameters needed to characterize the quality of the implosions. In addition, since the spectrometers view the implosion from many different angles, the implosion symmetry can be sensitively studied. In fact in recent work nine different spectrometers viewed imploding capsules and showed that significant non-spherical asymmetries exist. MIT data and analysis have contributed important insights into the relationship between experimental conditions and implosion performance and in doing so has advanced the state of ICF research. These spectrometers are prototypes for those being designed by MIT and collaborators for the National Ignition Facility (NIF) at Lawrence Livermore. For example, at the core of NIF implosions, we expect to achieve plasma densities that are 6 times larger than the density at the center of the Sun, or 52 times more dense than gold. Currently, the MIT/PSFC has the lead role in organizing and coordinating the Basic Science Users Group for the National Ignition Facility.

Novel Diagnostics for Magnetic Fusion Research

The Phase Contrast Imaging diagnostic (Professor M. Porkolab and Dr. C. Rost) was operated throughout the DIII-D tokamak 2001 experimental campaign, and analysis of the data is ongoing. New results and upcoming plans include the following:

- Turbulence measurements made by the PCI of otherwise identical plasmas with reversed magnetic geometry showed a change in the radial fluctuation propagation from inward to outward—this is a valuable clue in understanding the effects of velocity shear and magnetic geometry on tokamak edge fluctuations.
- Wavelet analysis of PCI measurements of edge localized modes (ELMs) has improved the time resolution of the measurement of the fast evolution of this complex phenomenon and will allow comparison with models of the initial linear phase.
- In response to a call for new proposals, a proposal has been submitted to the U.S. Department of Energy to upgrade the diagnostic to detect the high-frequency short-wavelength modes (Electron Temperature Gradient, or ETG modes) associated with the transport of electrons across the magnetic field lines. There is currently no diagnostic on any tokamak which performs such measurements. The upgrade will include moving the position of the diagnostic on the tokamak, changing the optics, and using faster electronics.

In other diagnostics work, the Plasma Technology Division (Dr. P. Woskov) continues research on the development of Collective Thomson Scattering (CTS) for energetic ion measurements in tokamaks. Recent developments at the JET (England) and TEXTOR (Germany) tokamaks have demonstrated the richness of energetic ion information provided by CTS. It has been shown that energetic ion localization, energy distribution and direction can all be determined in tokamaks to a degree not possible by other diagnostic techniques. A broad international collaboration is being planned for implementation on the ASDEX tokamak in Garching, Germany, using high frequency gyrotrons. A new proposal has been submitted to DOE, Office of Fusion Energy Sciences, to fund this upgraded program.

Ionospheric Plasma Research

Initial ionospheric plasma RF heating experiments have been conducted by Professor Min-Chang Lee (Visiting Scientist from Boston University) and his students in Alaska, using DoD's HF Active Aurora Research Program (HAARP) facility. These experiments are aimed at investigating ionospheric plasma turbulence and developing ELF/VLF communications schemes for high efficiency and good quality signals. In a new project, PSFC's Ionospheric Radar Integrated System (IRIS), after having been successfully tested last year, will be deployed for remote sensing of space plasmas during experiments in Alaska, Massachusetts, and Puerto Rico. A proposal was recently submitted for a DoD equipment grant, to acquire an optical instrument known as All Sky Imaging System

(ASIS), which can exhibit spatial structures of plasma turbulence. ASIS together with IRIS will provide powerful diagnoses of RF heated plasmas in space experiments.

WAVES AND BEAMS DIVISION

The Waves and Beams Division, headed by Dr. Richard Temkin, conducts research on novel sources of electromagnetic radiation and on the generation and acceleration of particle beams. Substantial graduate student involvement is emphasized in all research programs within the Division.

GYROTRON RESEARCH

The gyrotron is a novel source of microwave, millimeter wave and submillimeter wave radiation. Gyrotrons are under development for electron cyclotron heating (ECH) of present day and future plasmas, for high frequency radar and for spectroscopy. These applications require tubes operating at frequencies in the range 90–500 GHz at power levels of up to several megawatts. Dr. Michael Shapiro leads the Gyrotron Research Group. In 2001, we have begun testing a new 110 GHz gyrotron oscillator intended to operate at the 1 to 1.5 MW power level. The new gyrotron will be tested at both MIT and at an industrial vendor, Communications and Power Industries of Palo Alto, CA. The MIT gyrotron will operate in 3 microsecond pulse lengths while the industrial tube should be capable of continuous wave (CW) operation. Research challenges include operation of the gyrotron in stable, single-mode oscillation without mode competition; production of a high quality electron beam; achievement of high interaction efficiency in the resonator and achievement of very high overall efficiency (>50 percent) when operated with a depressed collector.

In gyrotron research, it is also critical to have a high efficiency mode converter that can transform the output mode of the gyrotron into a Gaussian beam in free space. In recent years, we have been studying the measurement of the phase distribution in microwave beams using a phase retrieval algorithm based on the measure field amplitude on a series of planes. In 2001, we have completed the first demonstration of a new approach to determining the phase distribution in the beam. This method uses the measured field amplitude on a series of planes but relies on calculated moments of the field amplitude to determine the parameters of a polynomial expansion of the spatial phase distribution. This irradiance moment method, which has been previously used at optical wavelengths, is being applied to microwave frequencies for the first time at MIT. The method will be applied to design single mirror correctors for the gyrotrons at General Atomics in San Diego. A new idea for a gyrotron microwave window, a dome shaped window, is also under investigation. This research is primarily sponsored by MIT Lincoln Lab through their Advanced Concepts Committee (ACC) internal funding program. Dynamic tests of this window, at high pressure and temperature, have been completed in 2001. The results show that the dome window concept is capable of operation at up to 1 MW of power.

In 2001, a new concept in vacuum electron devices (or microwave tubes) was demonstrated, namely a photonic bandgap (PBG) cavity gyrotron. Recently, the Gyrotron Research Group has demonstrated a new technique for building high frequency microwave sources with resonator dimensions many times the operating wavelength. In traditional larger dimension resonators, the electron beam can excite many resonant modes at once. The resulting output is very inefficient and is not useable. The novel resonator in the MIT experiment was made of a photonic band gap (PBG) structure, a two dimensional array of metal posts which reflects only certain frequencies while being transparent to other frequencies. This allows a much larger sized resonator to support only one higher order mode while eliminating all other unwanted modes in the vicinity of the operating mode. Output power of 25 kW at 140 GHz was achieved in the desired with no competing modes observed over a 30 percent frequency range. This research received special notice in Physical Review Focus, the Boston Globe Science Section and Laser Focus World magazine.

Intensive research continues on a 250 GHz gyrotron for use in electron spin resonance and nuclear magnetic resonance studies. Reliable operation for many hours was achieved this year with operation at CW power levels of up to 25 W and pulsed power levels of up to 100 W. This research, funded by NIH in collaboration with Prof. Robert Griffin of the Magnet Lab, is a pioneering effort in high frequency electron spin resonance studies. Signal enhancements of sixty have been demonstrated in initial NMR experiments. A new gyrotron operating at the second harmonic was designed in 2001 for use in a new NMR spectrometer. The gyrotron, designed to operate at 460 GHz, will be used in conjunction with a 17 T magnet system recently installed at the Francis Bitter Magnet Laboratory. The 460 GHz gyrotron design has been completed and the long lead time items, including a superconducting magnet have been ordered. This gyrotron is expected to operate in 2002. In a new program, we have been funded as part of a DoD MURI consortium for Innovative Vacuum Electronics. A 95 GHz amplifier is being constructed with first tests planned at 140 GHz using available equipment. A gyrotron amplifier with a confocal waveguide structure has been built and will be tested in 2002.

HIGH GRADIENT ACCELERATOR RESEARCH

The High Gradient Accelerator Group is conducting research on a novel, 17 GHz, microwave driven, photocathode electron injector. This device, sometimes called an RF gun, can generate a 2 ps beam of 1-2 MeV, 50-500 A electrons at high repetition rate. A 26 MW, 17.1 GHz klystron power source drives the electron gun. The electron beam can be directly applied to microwave generation experiments or it can be used as an injector into a 17 GHz, high gradient accelerator. This research supports the program to build new electron accelerators that can reach the TeV range of energies. In 2001, the emittance of the electron beam from the RF photocathode gun has been

measured to be 3 (pi) mm mrad for a 50 pC electron bunch, close to a record high value of beam brightness. A new electron gun that can achieve higher electron beam energies, over 2 MeV, and higher beam quality has been designed, built and tested. Results indicated that high order, quadrupole modes need to be eliminated in order to achieve improved beam brightness. Commissioning continued in 2001 of the Haimson Research Corp. 17 GHz electron accelerator. This is the highest power accelerator on the MIT campus and the highest frequency stand-alone accelerator in the world. One potential application of this accelerator is in free electron laser research. Improvements to the 17.1 GHz klystron have been made in 2001 to secure reliable operation at power levels of at least 15 MW at 17.14 GHz. The operation of the accelerator has been successfully simulated using advanced codes. This research program should establish 17 GHz as a feasible frequency for future TeV electron colliders.

THEORETICAL RESEARCH IN BEAMS AND NON-NEUTRAL PLASMAS

The Intense Beam Theoretical Research Group, led by Dr. Chiping Chen, has contributed very significantly to our understanding of coherent radiation generation and particle acceleration. Topics covered include coherent radiation sources (crossed-field devices, CARM, FEL, gyrotron, relativistic klystron, relativistic TWT), intense electron and ion beam transport, mechanisms and control of beam halo formation, cyclotron resonance accelerators, photocathode design, and related topics. Research explores self-field-induced nonlinear resonant and chaotic phenomena in intense charged particle beams. This research supports the U. S. program to construct advanced accelerators for such applications as nuclear waste treatment, heavy ion fusion and free electron lasers. In 2001, a new Green's function based modeling technique was applied to studies of self-fields in bunched electron beams in such high-power klystrons as those that are being developed at the Stanford Linear Accelerator Center (SLAC) for driving the Next Linear Collider (NLC). A Photonic Band Gap Structure Simulation (PBGSS) code was written and applied in the modeling and design of photonic crystal based active radiation devices. A breakthrough was made in the understanding of high intensity sheet beams. Also gained is a better understanding of the equilibrium and confinement of bunched annular beams in high-power microwave sources.

PLASMA TECHNOLOGY DIVISION

The objectives of the Plasma Technology Division, led by Drs. Daniel Cohn and Paul Woskov, are to develop new fusion spin-off applications, particularly in the environmental and energy efficiency area; to develop new fusion diagnostics; and to develop new fusion reactor system concepts. A major thrust is in the area of plasma aided conversion of hydrocarbon fuels into hydrogen. Hydrogen has potential environmental advantages as a fuel or a fuel additive that can greatly reduce pollution from vehicles and stationary electricity generation systems. It can also be used to increase the efficiency of conversion of hydrocarbon fuels into mechanical power or electrical power. The use of hydrogen can facilitate high efficiency, lean burn spark ignition engine operation. It can be used in high efficiency fuel cells for electricity generation.

One project in the area of plasma aided conversion of hydrogen into hydrocarbon fuels investigates the use of plasmatron devices for manufacturing hydrogen for use in stationary fuel cell facilities. A second project, which is the major activity, is investigating the vehicular use of compact plasmatron devices for onboard conversion of gasoline into hydrogen-rich gas. The hydrogen-rich gas would then be combusted in a slightly modified spark ignition engine. Using the hydrogen-rich gas as an additive to gasoline, large reductions in NO_x, a major air pollutant, can be obtained. By facilitating high compression ratio lean burn operation, the use of hydrogen rich gas could also increase net engine system efficiency by up to 25 percent. The modified engine system including the plasmatron devices could have a cost as low as $500. Fuel savings could result in a payback time of as short as two years. The rapid payback time could potentially make possible widespread implementation on cars and light duty vehicles which could eventually lead to a gasoline savings in the United States of 20 billion gallons a year. A major program in collaboration with Professor John Heywood of the Mechanical Engineering Department and the Sloan Automotive Laboratory is being initiated with support from Arvin Meritor, a leading global manufacturer (headquartered in Troy, MI) of exhaust systems and other automotive systems. A third project investigates the use of plasmatron generated hydrogen as a means to improve catalytic reduction of diesel engine exhaust.
The Plasma Technology Division is also investigating the use of millimeter wave reflectometry and pyrometry for measurement of the properties of glass produced in vitrification of radioactive waste. The objectives of this technology development effort is to contribute to DOE environmental management needs of maximizing glass loading, optimizing durability of long-stability glass, and reducing long-term storage volumes. The technology earned an R&D 100 Award as one of the most significant new technologies in 2001.

TECHNOLOGY AND ENGINEERING DIVISION

The Technology and Engineering (T&E) Division, headed by Dr. Joseph Minervini, conducts research on conventional and superconducting magnets for fusion devices and other large-scale power and energy systems.

As usual, the major emphasis of the Division's effort has been on support of the U.S. Fusion Program where the PSFC has the leadership responsibility for the Magnets Enabling Technology program. A major effort was devoted to analysis of the large amounts of data generated by the successful testing of the Central Solenoid Model Coil (CSMC) in 2000 at the Japanese Atomic Energy Research Institute (JAERI) in Naka, Japan. Collaboration with JAERI continued on this project with Dr. Philip Michael participating in the installation of the next Toroidal Field Coil Insert module (TFCI) in Naka. The Division's lead experimentalist, Dr. Makoto Takayasu is now at the test site participating in the TFCI test program, while data is simultaneously being transferred to MIT and analyzed here.

Professor Ronald Ballinger continued materials development on the superalloy Incoloy Alloy 908 in the Materials Science and Technology Laboratory of the Technology and Engineering Division. Most recent research is focused on modifications to the Alloy 908 to reduce oxygen embrittlement sensitivity during high temperature reaction heat treatment of the superconductor.

The division continued to play an important role in technology development of magnet systems and in quadrupole magnet array design studies for the Lawrence Berkeley National Laboratory's High Current Transport Experiment (HCX) and the Integrated Research Experiment (IRE). HCX and IRE are the main elements of the US Heavy Ion Fusion Driver program, a major focus of Inertial Fusion Energy (IFE) research. During the past year, in addition to the design studies and quadrupole analysis, the division tested two superconducting quadrupole coils fabricated in industry as prototypes for the HCX, and performed data analysis of the coil performance.

Manufacturing of the magnet systems for the Levitated Dipole Experiment (LDX) continued during this past year. Major components of the cryostat for the Nb_3Sn Floating Coil (F-Coil) were completed. Fabrication of the Charging Coil (C-Coil) continued at the D.V. Efremov Scientific Research Institute of Electrophysical Apparatus in St. Petersburg, Russia. Division staff are monitoring the design and fabrication process. The high temperature superconductor (HTS) tape was delivered and fabrication of the Levitation Coil (L-Coil) was begun in industry.

The division provided engineering support to the Princeton Plasma Physics Laboratory in the evaluation of Next Step Options for the US Fusion Program and in the design of the Fusion Ignition Research Experiment (FIRE). MIT continues to play a lead role in the magnet system design, cryogenic system design, and structural design for the FIRE as well as systems level studies.

Research continued under sub-contract to the Samsung Advanced Institute of Technology for magnets and magnet systems design for the Korean K-STAR superconducting tokamak program.

In the area of technology support for the high energy physics program, the division was the successful bidder for the NSF funded "Conceptual Design Study for a Muon-Electron Conversion (MECO) System of Superconducting Solenoids." This is a very large system of complex superconducting magnets that will form the core of the MECO experiment to be located at the Brookhaven National Laboratory. The contract origin is the University of California-Irvine where the lead investigator for the MECO collaboration is located. Approximately two man-years of effort are being applied by the T & E Division, including internal collaboration with Professors Joseph L. Smith, Jr., and John Brisson from the Department of Mechanical Engineering. We believe there will be follow-up funding in FY2002 for overseeing detailed design and procurement of the magnet system in industry.

A small design effort was carried out this year for the superconducting magnet system for the "Neutrino Factory." as part of a collaborative proposal submitted through Brookhaven National Laboratory to DOE. We have received an expression of interest from BNL to perform the design of an early phase pulsed, nitrogen-cooled copper magnet for this project. We hope to carry out that project early in FY2002 by collaborating with engineers from the Alcator Division.

The division continued it's important role in design and development of proton radiography superconducting quadrupole focusing magnets for the Advanced Hydrodynamic Facility (AHF) being designed at the Los Alamos National Laboratory. More detailed design was performed this year on the large bore superconducting magnets. This should lead to an expanded role for MIT in FY2002 for development in industry of some prototype magnets.

The division has contracts as the Research Institution for two NASA funded STTRs, in collaboration with the Advanced Magnet Laboratory, Inc., a Florida based small business. We are now performing a Phase II design of the superconducting model coils for an electromagnetic catapult, "MagLifter", to lower the cost of cargo delivery to space. We are performing the conductor and coil design and will test the coils at MIT after AML fabricates them. We are also working on another joint Phase-I STTR from NASA to study a superconducting magnetic energy storage system (SMES) as a pulsed power source for the MagLifter launch concept.

A proposal was submitted to NASA for a Cooperative Agreement on HEDS Technology Development/Commercialization Initiative. The project title was "Development of Advanced, Lightweight Superconducting Magnets for Plasma Rockets," to be performed in collaboration with the Advanced Space Propulsion Laboratory at the Johnson Space Center. Although we were successful in being notified by NASA that our proposal was accepted for funding, changes in the FY2001 budget for NASA did not allow them to fund any of the accepted proposals. We are hopeful that we can resubmit again in FY2002 if the program funding is returned. A proposal was resubmitted to NIH for the development of a new device to separate blood components for therapeutic purposes by use of magnetic separation. The NIH review gave very good results and we are hopeful that we will be notified of funding award this October.

EDUCATIONAL OUTREACH PROGRAMS

The Plasma Science and Fusion Center's educational outreach program is planned and organized under the direction of Mr. Paul Rivenberg, Communications and Outreach Administrator of the PSFC. The program focuses on heightening the interest of K–12 students in scientific and technical subjects. The PSFC seeks to educate local

students and the general public by conducting general tours of experiments being done here. Special "Outreach Days" are held twice a year, encouraging high school and middle school students from around Massachusetts to visit the PSFC for a day of hands-on demonstrations and tours.

The Mr. Magnet Program, headed by Mr. Paul Thomas, is completing its ninth year of bringing lively demonstrations on magnetism into local elementary and middle schools. This year Mr. Magnet presented the program to over 30,000 students at over 77 schools and other events, reaching students from Kindergarten through college freshmen. He makes a special effort to encourage girls to consider a science-related career. In Spring 2001 Paul Thomas traveled with his truckload of equipment to Washington, DC, at the request of the Department of Energy, to involve participants of the DOE National Science Bowl with his hands-on magnetic experiences. While there he took the occasion to visit schools in the Germantown, MD area, inviting DOE sponsors to observe his program in action. To supplement his traveling show, Paul is creating a number of specialized workshops at the PSFC, In the summer of 2001 he will be guiding a class of middle school students through the process of creating their own electromagnets.

Paul Thomas also contributed to the success of the MIT Museum's "Thinkapalooza" exhibit, which opened in the Fall of 2000. Paul created a wonderful big toy that curious students can use to create plasmas, and see how they change when different gases and different frequencies are used. The demonstration has remained a part of the MIT Museum exhibit even after the Thinkapalooza show ended. Paul Rivenberg collaborated with MIT Museum staff to organize this effort, and brought in Administrative Assistant Mary Pat McNally to contribute graphic designs.

The PSFC continues to work with other national laboratories to educate students and the general public. An annual Teacher's Day (to educate teachers about plasmas) and Open House (to which they can bring their students) has become tradition at each year's APS-DPP meeting. Paul Rivenberg and Research Scientist Réjean Boivin aided organizers of the 2000 education events in Québec, which attracted over 150 teachers, and received much attention from the Québec press. Mr. Rivenberg continues to work on similar events scheduled for Long Beach (APS-DPP meeting, fall 2001) and Atlantic City (IEEE meeting, fall 2001). At these events the PSFC plans to bring an improved version of their "C-Mod, Jr. Video Game," which teaches students about how we confine plasmas in a tokamak. It will be upgraded with the help of PSFC graduate students in the summer of 2001. Paul Thomas is also working on a portable plasma demonstration to bring to the APS-DPP meeting.

Technical Supervisor Robert Childs, as part of the American Vacuum Society Meeting in Boston (October, 2000), helped organize a science education workshop for teachers who attended the conference. Attendees met at the PSFC where they received instruction, as well as tours of the facilities.

The PSFC continues to be involved with educational efforts sponsored by the Coalition for Plasma Science (CPS), a growing organization formed by members of universities and national laboratories to promote understanding of the field of plasma science. Associate Director Dr. Richard Temkin, who oversees PSFC education efforts, is working with this group on goals which include requesting support from Congress and funding agencies, strengthening appreciation of the plasma sciences by obtaining endorsements from industries involved in plasma applications, and addressing environmental concerns about plasma science, particularly fusion. This year CPS sponsored a well-attended congressional luncheon in Washington, DC, during which NASA Astronaut and former MIT PSFC Visiting Scientist, Dr. Franklin Chang-Diaz, explored the topic of plasma propulsion for space travel. Paul Rivenberg has continued his duties as editor of the Coalition's *Plasma Page*, a summary of plasma-related news items of interest to the media. Mr. Rivenberg also heads a subcommittee which this year created a web site to help teachers bring the topic of plasma into their classrooms. The site will continue to improve and expand. Paul has also joined the Technical Materials subcommittee, where he oversees content and design of two-page information sheets that will introduce the layman to different areas of plasma science.

APPOINTMENTS AND PROMOTIONS

During the past year, there have been a number of appointments and promotions in Plasma Science and Fusion Center program areas:

Appointments

Alcator Division: Mr. Xiwen Zhong was appointed Research Engineer; Mr. Richard Murray RF Instrumentation Engineer; and Dr. Yijun Lin Postdoctoral Associate.

Physics Research Division: Dr. Peter Catto was appointed Senior Research Scientist as well as Assistant Director and head of the PSFC Theory Program; Dr. Andrei Simakov was appointed Postdoctoral Associate, and Ms. Ayse Bilgin was appointed Research Specialist.

Waves and Beams Division: Dr. Michael Shapiro was appointed Research Scientist.

In the Administrative area, Mr. John Defandorf was appointed Assistant Fiscal Officer.

Internal Promotions
Alcator Division: Dr. Martin Greenwald was promoted to Senior Research Scientist; Dr. John Rice to Principal Research Scientist; and Mr. Rui Vieira to Chief Mechanical Engineer.

Physics Research Division: Dr. Abhay Ram was promoted to Principal Research Scientist and Drs. Jan Egedal-Pedersen and Jon Rost Research Scientists.

Technology and Engineering Division: Dr. Joseph Minervini was promoted to Senior Research Engineer.

In the Administrative area, Mr. Jason Thomas was promoted to Library Administrator.

GRADUATE DEGREES
During the past year, the following departments granted students degrees with theses in plasma fusion and related areas:

- Nuclear Engineering: Nathan Dalrymple, Ph.D.; Seung Kee Min, Ph.D.; George Haldeman, Ph.D
- Physics: Yijun Lin, Ph.D.; Alexander Mazurenko, Ph.D.; Andrei Simakov, Ph.D.

More information about the Plasma Science and Fusion Center can be found online at http://www.psfc.mit.edu/.

Miklos Porkolab

RESEARCH LABORATORY OF ELECTRONICS

The Research Laboratory of Electronics (RLE), founded in 1946, is the Institute's first interdisciplinary research laboratory. Today it is the largest such laboratory at MIT in terms of faculty and student participation. RLE grew out of the wartime MIT Radiation Laboratory and was formed to bring together physicists and electrical engineers to work on problems in electromagnetic radiation, circuits, and specialized vacuum tubes. Over the years, RLE's research interests have branched in many directions and have led to the creation of additional laboratories. Research within RLE is conducted by approximately 40 faculty members who are affiliated with the Departments of Electrical Engineering and Computer Science, Physics, Chemistry, Materials Science and Engineering, Aeronautics and Astronautics, and Linguistics. During the past year, approximately 250 graduate students and 60 undergraduates pursued research within RLE. The research is supported primarily by: the Department of Defense (DoD) agencies; the Department of Energy (DOE); the National Science Foundation (NSF); the National Institutes of Health (NIH); and the National Aeronautics and Space Administration (NASA). In addition, numerous projects are funded through industry and private foundations. RLE research is widely varied and consists of two major thrust areas and several smaller focus areas. One thrust area is centered on electronics and optics; the other is centered on language, speech, hearing, and sensory communication.

Detailed information about RLE research in the calendar year 2000 can be found in the *RLE Progress Report No. 143*. The report can be accessed electronically at http://rleweb.mit.edu/Publications/prog.htm. We summarize here research highlights during the past year.

ELECTRONICS AND OPTICS

Materials And Fabrication

Professor Leslie Kolodziejski has demonstrated a 100x enhancement in the extraction efficiency of a light-emitting diode by incorporating a two-dimensional photonic bandgap (PBG) structure into the top cladding layer of the diode. This work, which was done in collaboration with Professors John Joannopoulos, Erich Ippen and Henry Smith of RLE, is part of a suite of PBG structures that are being developed for applications such as optical switches, low-loss waveguide corners, and super-prisms.

Professor Henry Smith has developed high-performance, in-line grating-based optical resonators that presage a new era of highly integrated, chip-based micro-photonic systems for communication and computation. He has also developed lithographic and pattern-transfer processes for magnetic random access memory (MRAM), and observed proper switching of the magnetic layers down to 50-nm-wide elements. This is an important step on the path to very high density, non-volatile memory to replace DRAMs.

Dr. James Goodberlet is developing near-field photolithography, a low cost method for patterning features with dimensions well below 100 nm, and using this technology to fabricate integrated vacuum-electronic and integrated-optical devices. In recent experiments, he has reliably patterned 45-nm-diameter holes and posts, a dimension substantially below the diffraction limit of the 220-nm-wavelength exposing radiation.

Professor Vladimir Bulovic is in the process of developing a versatile materials growth system that will be capable of depositing molecular organics, polymers, metals, metal oxides, inorganic nanodots, and colloids in a controlled layer-by-layer fashion. This system will include *in-situ* capabilities for fabrication of complex patterned structures and for electrical testing.

Optics and Devices

Professor James Fujimoto has continued to pioneer optical coherence tomography (OCT), an emerging medical imaging technology that is analogous to ultrasound imaging except that it uses light rather than sound. During the past year, he has developed techniques that enhance the image resolution of OCT by almost 10x, from 10-15 μm to 1 μm. Professor Fujimoto is currently performing preliminary clinical studies of various OCT techniques with the Brigham and Women's Hospital, the National Cancer Institute, and the Lahey Clinic.

Professor Erich Ippen has continued his work on the development novel femtosecond lasers and their application to precision-measurement systems. Together with Professors James Fujimoto, Hermann Haus, and Frans Kaertner, he has demonstrated octave-wide optical comb generation in a phase-locked sub-2-cycle Ti:sapphire laser. This source will find increasing application in optical frequency standards and optical clocks. Professors Ippen, Fujimoto, and Kaertner have also established records for the shortest duration pulses produced from a Cr:fosterite laser (13 fs) and a Cr:YAG laser (20 fs). These sources will greatly expand the spectral coverage for optical frequency standards.

Professors Hermann Haus and Erich Ippen have achieved a record soliton noise squeezing of 6.1 dB. This experiment, which confirmed theoretical predictions concerning the evolution of a quantized soliton, is the forerunner of precision measurement systems whose sensitivity exceeds the conventional shot-noise limit.

Professors Haus and Ippen also characterized, both theoretically and experimentally, the timing jitter of mode-locked fiber lasers. Low-jitter fiber lasers are promising candidates for timing sources in broadband analog-to-digital converters.

Professor Qing Hu is continuing research on lasers and electronics for the THz frequency region. During the past year he has studied the role of complex phonon spectra on intersubband scattering rates, and obtained one of the narrowest linewidths (0.18 THz) ever seen from intersubband emission.

Surfaces and Interfaces
Professor John Joannopoulos has engaged in surface and interface structure calculations aimed at solving the problem of combining opto-electronics, that rely on direct-bandgap III-V semiconductor alloys, with indirect-bandgap silicon integrated electronics. His calculations show that a new semiconductor alloy, $Zn_{0.5}Si_{0.5}P_{0.25}As_{0.75}$, should eliminate the charge mismatch encountered at III-V/Si interfaces, have a lattice constant that is within 0.1 percent of Si, and should possess a direct bandgap at optical fiber communication wavelengths. Additional research has characterized 27 novel material compounds that span a region of bandgap/lattice-constant phase space that was hitherto inaccessible. Experimental efforts are currently underway at MIT to fabricate some of the most promising of these materials. Both U.S. and International Patents are pending for this new class of materials.

Circuits and Systems
Professor John Wyatt is continuing his research on the microchip retinal implant. As part of this project, blind patients have had electrode arrays temporarily placed in their eyes via surgical procedures done under local anesthesia. The patients have then been asked to describe their perceptions when these arrays are electrically stimulated with spatial patterns. Every patient has seen something resulting from the stimulation, but thus far the perceptions do not closely match the stimulation patterns. The ultimate goal of this work is to restore some level of useful vision to those suffering from macular degeneration or retinitis pigmentosa.

Professor Rahul Sarpeshkar is working on an ultralow power analog bionic ear for the deaf, pulse-based hybrid analog-digital circuits, and the design of ultralow-noise electronics for MEMS capacitive sensors. During the past year, he successfully implemented a 3 μW, 70 dB dynamic range, active bandpass filter for the front-end of the bionic ear.

SPEECH, HEARING, AND SENSORY COMMUNICATION

Speech Communication
Professor Kenneth Stevens is developing a model of the process by which human listeners identify words in running speech, as well as methods for using acoustic data to aid in quantifying the diagnosis of disordered speech production. The results of his work will have application in the development of improved algorithms for speech synthesis from text and for automatic speech recognition.

Dr. Joseph Perkell has been gathering data in a multi-faceted experiment that addresses the hypothesis that speakers use the same set of auditory goals in both production and perception. His work could have long-term applications in methods for diagnosing and treating communication disorders.

Dr. Stefanie Shattuck-Hufnagel is studying the effects of prosodic structure and prominence on the phonetic implementation of the sounds of words along with the cognitive process of phonological encoding that speakers use to generate these effects. Her work provides a way of thinking about the generation of prosodic structure that can address the challenges of natural spontaneous speech, something that is missing from previous linguistic, cognitive, and engineering approaches to speech production.

Sensory Communication
Dr. Thomas Wiegand has initiated a program on visual psychophysics via uncontrolled channels. Its aim is to administer tests of sensory performance (initially visual performance) via the World Wide Web. He has developed a color vision test that can be viewed using common Web browsers, and provides usable results even on miscalibrated monitors. Not only is this test applicable to routine screening of school children, but it also has implications for the control and tracking of environmental pollutants. This connection arises because of the tendency of certain toxins to cause progressive yellow/blue color blindness.

Dr. Charlotte Reed is developing tactual aids for persons who are profoundly deaf or deaf-blind. Her recent work has shown that a two-channel tactual display provides sufficient information for distinguishing voiced from voiceless speech segments, both through the tactual display alone and when used in combination with lipreading. These results may lead to major improvements in tactual speech communication aids for the deaf.

Dr. Andrew Oxenham is continuing research on auditory perception and cognition. In collaboration with Drs. Christopher Shera and John Guinan of the Massachusetts Eye and Ear Infirmary, he has developed a new measure of inner ear function that relies on otoacoustic emissions, i.e., the sounds produced by the ear itself. This noninvasive technique has enabled comparisons to be made across many different species, including human. The results demonstrate that frequency tuning in the human cochlea is considerably sharper than that in the animals typically used as physiological models for hearing, i.e., the cat and the guinea pig.

Auditory Physiology
Professor Dennis Freeman has measured the motions of sensory cells in the inner ear of a lizard in response to sound stimulation. He also measured the mechanical properties of the tectorial membrane—a key tissue that mechanically

stimulates hair cells—obtaining the first quantitative measurements of its bulk modulus, fixed-charge concentration, and point impedance.

Dr. Bertrand Delgutte is studying the neural mechanisms for perception of sounds. He has found that most neurons in the auditory midbrain respond preferentially to pairs of tones forming dissonant musical intervals than to pairs of tones forming consonant intervals. These findings, which show that percepts generally considered to be cognitive have direct correlates in the responses of auditory neurons, may help design better hearing aids and cochlear implants.

Dr. Donald Eddington is working on a variety of issues related to cochlear implants. During the past year he has developed a measure of the interaction between the electrodes in the stimulus array of such implants. Using this measure, he has demonstrated a new electrode design that reduces the interaction, thus allowing the number of information channels to be nearly doubled. Tests of speech reception in one subject showed a dramatic improvement using the new electrode system.

FOCUS AREAS

Atomic, Molecular, and Optical Physics

The Center for Ultracold Atoms (CUA) was established at MIT and Harvard under NSF sponsorship. RLE's Associate Director, Professor Daniel Kleppner, is the Director of CUA. The CUA's research program encompasses experimental and theoretical work on Bose-Einstein condensates (BECs), atom optics, cryogenic sources for BECs.

Professor Wolfgang Ketterle is continuing to study the properties of Bose-Einstein condensates, and to further develop the atom laser, an intense coherent beam of atoms. During the past year, he has observed the formation of highly-ordered vortex lattices in a rotating Bose-condensed gas. Because these observations were free from distortions, even near the boundary, they may provide a model system for the study of vortex matter. Such a system would be important because quantized vortices play key roles in superfluidity and superconductivity.

Professor David Pritchard has been applying atom interferometry toward both fundamental and applied problems such as studying quantum mechanics and making better gyroscopes. In recent measurements, he has quantitatively explored wave-particle duality, perhaps the most counter-intuitive aspect of quantum mechanics. Scattering multiple photons off atoms inside an atom interferometer caused loss of quantum coherence (i.e., wave behavior) in accord with general theories of decoherence. This was the first experiment to make such comparisons with no adjustable parameters.

Plasma Physics

Professor Abraham Bers is studying laser-plasma interactions, ionospheric modeling, and heating in magnetically-confined plasmas. Recent highlights from his research include unique experiments, done in collaboration with Los Alamos National Laboratory, designed to characterize the interaction of a single laser hot spot with a pre-formed laser-produced plasma. Stimulated Raman scattering and its coupling to Langmuir decay instability cascades were observed unequivocally for the first time.

Professor Bruno Coppi is working on a broad range of problems associated with high-energy plasma physics, including the design and study of advanced experiments for magnetically-confined fusion ignition, the development of new areas in computational plasma physics, and the analysis of astrophysical accretion disks. His analysis of the optimal regimes for fusion ignition in a high magnetic field has been confirmed by results from the FTU experiment in Italy.

Remote Sensing And Estimation

Professor David Staelin has developed the iterative order and noise (ION) estimation algorithm, which is capable of retrieving multivariate signal information from noisy data, and successfully applied it to detect tachycardia 140 seconds in advance from 31-state patient-state data obtained during anesthesia. In the area of atmospheric remote sensing, he has developed improved methods for estimating precipitation rate from microwave satellite data, and shown that these retrieval methods respond strongly to snowfall, a parameter that is extremely difficult to measure remotely with accuracy.

Dr. Philiip Rosenkranz is carrying out research on the inversion of microwave radiometer measurements made from aircraft or satellites to obtain profiles of temperature and moisture in the atmosphere. The microwave components of his algorithms for NASA's Aqua spacecraft were successfully tested with data from the NOAA-15 weather satellite.

Digital Signal Processing

Professor Alan Oppenheim is addressing the development and application of new paradigms and algorithms for signal processing. Highlights from last year include development of a generalized frequency modulation, quantum signal processing for matched-filter detection of multiple signatures in multi-user detection systems. Patent applications have been filed on several of these advances.

Professor Gregory Wornell is doing research on fundamental principles and algorithms for wireless and broadband communication networks, and multimedia signal processing. His work on cooperative diversity techniques, which

forms virtual antenna arrays by coordinating the transmissions from handheld devices, both combats multipath fading and dramatically extends battery life. Professor Wornell has developed a suite of interference suppression algorithms for wireless communications that, with linear complexity, asymptotically achieve the best possible performance of any technique. He has also developed a new generation of digital watermarking algorithms that are compelling candidates for next-generation copyright notification and enforcement.

Advanced Television And Signal Processing
Professor Jae Lim's work concerns the development of signal processing theories and their applications to real-world problems in video, audio, and digital communications. During the past year, research has continued on migration approaches for higher-resolution digital television. Preliminary results, which rely on the use of video enhancement bits, have been encouraging, making these techniques potentially the basis for a future standard. The approaches that are being developed may also be used for the development of scalable video systems.

Electromagnetics
Professor Jin Kong is working on electromagnetic wave theory and its applications. During the past year, his research has focused on polarimetric passive remote sensing, synthetic aperture radar (SAR) simulation, wide-band antenna applications, scattering by large objects, electromagnetic waves in multilayer media, and negative isotropic materials. His polarimetric remote sensing work has been used as a basis in the WindSat satellite for measuring ocean wind directions.

Quantum Communication
Professor Jeffrey Shapiro is the leader of a Multidisciplinary University Research Initiative on quantum communication involving researchers from MIT and Northwestern University. As part of this effort, Professor Seth Lloyd and Dr. Selim Shahriar have conceived a trapped-atom quantum memory that, together with an ultrabright source of polarization-entangled photons (conceived by Professor Shapiro and Dr. Franco Wong) forms the basis for an architecture for long-distance quantum communication. Experimental work is now underway to develop both the memory and the entanglement source. Development of this technology will permit quantum computers to be networked and open new approaches to secure communications.

Professor Seth Lloyd has shown that quantum effects can be used, in principle, to dramatically improve the accuracy of radar and position-sensing measurements. Essentially any method for determining distance or time that operates by sending pulses of light from one place to another can be improved by his method.

Individual Research
Professor Donald Troxel has been developing CAD tools for reliability analysis of 3-D integrated circuits. As part of this effort, he has developed a methodology and supporting CAD software for designing 3-D ICs. Prior to this work, layouts for such circuits were always done by hand.

APPOINTMENTS AND AWARDS
Professor Jeffrey Shapiro succeeded the late Prof. Jonathan Allen as the Director of RLE.

Drs. Gale Petrich and Selim Shahriar were promoted to Principal Research Scientist.

Professor James Fujimoto was elected to the National Academy of Engineering.

Professor Erich Ippen received the James R. Killian, Jr., Faculty Achievement Award.

Professor Seth Lloyd received the Harold E. Edgerton Faculty Achievement Award.

Professors Vladimir Bulovic and Rahul Sarpeshkar received National Science Foundation Faculty Early Career Development (CAREER) Awards.

Dr. Andrew Oxenham received the R. Bruce Lindsey Award of the Acoustical Society of America.

Ms. Mary E. Young, and Mr. David W. Foss received 2001 MIT Infinite Miles Awards.

AFFIRMATIVE ACTION
RLE has worked and will continue working to increase the number of women and minorities in career positions in the laboratory, in the context of the limited pool of qualified technical applicants and the unique qualifications of RLE's sponsored research staff. Specific measures will include: maintaining our high standards for recruitment procedures that include sending job postings to minority colleges and organizations; working closely with the RLE faculty/staff supervisor at the beginning of each search to identify ways of recruiting minority and women candidates for the new position; and being committed to finding new techniques to identify more effectively women and minority candidates. During the past year, due to limited turnover in RLE's research staff, success in affirmative action for research staff has been limited. The one research staff appointment for this year was made to a woman.

More information about the Research Laboratory of Electronics can be found online at http://rleweb.mit.edu/.

Jeffrey H. Shapiro

SEA GRANT COLLEGE PROGRAM

The MIT Sea Grant College Program provides funds for research, education, and technology transfer directed toward wise utilization of marine resources. MIT has been a leading participant in the national program since 1969. In 1976 the Institute was designated a Sea Grant College Program. Sea Grant College status offers the potential for greater funding and confers a responsibility to work with marine researchers throughout the Commonwealth.

Funds are distributed among the 30 Sea Grant Programs in a competing grant process by the National Oceanic and Atmospheric Administration through its National Office of Sea Grant. Each program is required to match every two dollars of its federal grant with one from non-federal sources. Congress established this matching provision to ensure that Sea Grant universities would be responsive to public and industry needs. Sea Grant provides funds explicitly for technology transfer through its mandate for advisory services and education in addition to its research mandate.

In FY2001 the National Office of Sea Grant awarded MIT over $2 million. MIT, industry partners, the Commonwealth, and other federal agencies provided more than $1.5 million. In all, these funds provided partial support for 14 faculty members, a senior research associate, a senior lecturer, seven post-doctoral and research fellows and 34 graduate students from MIT's Departments of Aeronautics and Astronautics, Chemical, Civil and Environmental, Mechanical, and Ocean Engineering, the Departments of Electrical Engineering and Computer Science, Biology, and Science, Technology and Society, as well as partial support for faculty, staff and students at UMASS/Amherst, UMASS/Boston, UMASS/Lowell, Boston University, Harvard University, Northeastern University, Temple University, Tufts School of Medicine, Massachusetts Maritime Academy, Woods Hole Oceanographic Institution (WHOI), the New England Aquarium, and the Quincy and Cohasset Public Schools

A five year $11.6 million award from the Office of Naval Research (ONR) having reached completion last year continues as a no-cost extension to assemble and process data, and prepare reports. This award was intended to further the development of the Autonomous Oceanographic Sampling Network (AOSN) and involved our Autonomous Underwater Vehicles Laboratory in collaboration with WHOI, the University of Washington, the University of California at San Diego (Scripps Institution of Oceanography) and the Monterey Bay Aquarium Research Institute (MBARI). Last year was also the second year of a two year $2.75 million award from ONR for a new autonomous research vessel to be used in the Atlantic Layer Tracking Experiment (ALTEX). Work continues as a one-year, no-cost extension to prepare reports. The ALTEX project has a number of collaborators including WHOI, MBARI (replacing Florida Atlantic University, an original collaborator) and a few commercial firms.

CORE RESEARCH

Research at MIT Sea Grant is guided by the unique intellectual resources of colleges and universities in the Commonwealth and by the needs of the marine community. Our research is divided into two categories. The first category is our core research program, which reflects the ongoing MIT Sea Grant (MITSG) management process and the guidance provided by our two advisory bodies: the State Advisory Council and the Faculty Committee. Within the core research area, we have four theme areas, with quite specific concentrations: Marine Biotechnology; Coastal Management and Utilization; Coupled Ocean Observation and Modeling; and Technology Development and Management for Ocean Uses. The second research category is our Focused Research, intended to address major regional and/or national issues or needs. Projects under focused research are also called Marine Center projects. In addition, Automation in the Manufacture of Marine Systems, now supported entirely from sources outside Sea Grant, continues to be one of Sea Grant's strongest activities. We continue to build upon advances made in these areas and have been able to compete successfully for other grants as a result.

Marine Biotechnology

Sea Grant's research objective in Marine Biotechnology is the advancement of technology that can contribute to better use of the biological resources of ocean and coastal ecosystems. Recently completed research has included studies of novel delivery systems for the vaccination of farmed fish and novel and potentially important research in seaweed as a source of compounds having commercial potential in food processing and pharmaceuticals.

On-going research in this thematic concentration included a project completed in February of this year—*Tissue Engineered Fish Skin*—led by Professor Robert Langer of the Chemical Engineering Department here at MIT with Professor Michael Triantafyllou of the Ocean Engineering Department as co-principal investigator. The objective of this research was to examine the feasibility of developing an artificial version of fish skin using tissue-engineering techniques. This research builds upon successful developments in human skin replacement using polymer chemistry technology to provide a support structure for dermal fibroplasts. These techniques, already approved for human use, could provide for breakthroughs in surface coverings for a new class of aquatic robots. The inclusion of Professor Triantafyllou in this research project recognizes the coupling of Langer's objectives and methodology with that of Triantafyllou's companion project to be discussed under the Technology Development and Management for Ocean Uses theme area—*Biomimetic Hull and Actuators for Fast-maneuvering Vehicles*—which includes Professor Langer as co-principal investigator.

Our annual solicitation in 1999 for new proposals resulted in a new research project in Marine Biotechnology—*Production of High Value Food Proteins from Low Value Underutilized Fish*—submitted by Professor Herb Hultin of UMASS/Amherst. This project began in March of 2000 and will run for two years finishing in February of 2002. Recent activity in this research area has focused on a process to produce fish protein isolates free of most insoluble components such as oil, membranes, skin, bones, and low molecular weight soluble impurities based on the solubility of fish muscle proteins. This most recent project delves into the problem caused by proteins of the fish tissues used that may not be easily separable from the desired proteins. These include the heme proteins and proteolytic enzymes. Due to density considerations, some insoluble pigment components are also difficult to remove. This project is viewed as a regional research project in that it involves supporting research by Professor Tyre Lanier of North Carolina State University and Professor Jae Park of Oregon State University—both funded by their respective Sea Grant programs.

COASTAL MANAGEMENT AND UTILIZATION

Research projects within the Coastal Management and Utilization theme area seek to advance the science and engineering needed to more effectively utilize our coastal and ocean resources and, either as an integral component or separately, increase our understanding of the marine ecosystem and our ability to influence its sustainability.

Completing its second and final year in February of 2001 was a research effort lead by Professor Philip Gschwend, Department of Civil and Environmental Engineering, MIT—*Sediment Quality Criteria (SQCs) for Polycyclic Aromatic Hydrocarbons (PAHs): Accounting for Pyrogenic Sources*. The primary objective in this research was to investigate how the effects of combustion-derived soot can be incorporated into predicting the exposures of marine benthic organisms to associated toxic substances.

Our solicitation for new research to begin March of 2000 resulted in two projects in Coastal Management and Utilization. *Combined Wave-Current Flows Over a Movable Rippled Bed*—led by Professor Ole Madsen of the Department of Civil and Environmental Engineering at MIT—attempts to extend his research into combined flows over fixed, artificial rippled beds to the more realistic case of beds consisting of movable sediments. These ripples, more closely representative of actual conditions, have the potential to change bottom geometry and hence flow resistance in response to the nature of the flow.

The second successful proposal in this theme area—*Quantitative PCR Combined with Constant Denaturant Capillary Electrophoresis for the Analysis of Naturally Occurring Pathogens in Coastal Environments*—with Professor Martin Polz of the Department of Civil and Environmental Engineering at MIT as the Principal Investigator, intends to develop and apply molecular techniques that allow the quantification of diversity and abundance of pathogenic vibrios in marine environmental samples. PCR or polymerase chain reaction is a laboratory procedure extensively used in molecular biology to isolate a DNA segment for study. This work is of great benefit in that the ability to quantify pathogenic organisms in the environment will aid in understanding patterns of transmission.

These two projects are now in their final year and will be completed in February of 2002.

Our annual call for new research projects to begin in March of this year again resulted in two successful proposals in this theme area. Professor Robert Chen, Environmental, Coastal and Ocean Sciences at the University of Massachusetts/Boston in collaboration with Professor Ana Soto of the Anatomy and Cellular Biology Department at Tufts School of Medicine submitted a proposal—*Identification of Endocrine Disrupters in Coastal Waters*—representing timely research intended to establish sources and distributions of estrogen, and androgen activity in Boston Harbor.

The second successful proposal was from Dr. Michael Tlusty of the New England Aquarium. His proposal—*Environmental Impacts of Lobster Pounds: Monitoring Impacts, Modeling Holding Capacity and Assessing Policy*-is concerned with the annual and long-term accumulation of organic matter in lobster pounds, and the modeling of the loading and fate of wastes in these pounds.

COUPLED OCEAN OBSERVATION AND MODELING

Our annual call (issued in February of each year) for new research and outreach proposals to begin in March of 1999 included a new theme area, Coupled Ocean Observation and Modeling, as the newest theme area in our core program. Having now reached completion this past February, *Integrated Mapping and Navigation for Autonomous Underwater Vehicles*, led by John Leonard, Associate Professor of Ocean Engineering, MIT, illustrates the tight coupling of this new theme area with the traditional activities of the Autonomous Underwater Vehicle (AUV) program at MIT. The objective of this proposed research was to develop an algorithm for integrated mapping and navigation (IMAN) for AUVs and to verify its performance with real data. The ultimate aim of integrated mapping and navigation is to enable AUVs to build and maintain feature-based maps of the ocean environment from sonar data and to use these maps to navigate for long duration missions over large areas of the ocean.

In our solicitation for new research to begin in March of last year (2000) there were two additions in the Coupled Ocean Observation and Modeling theme area. *Acoustic Sensing of Sediment Properties Using a WWW-Controlled Shallow Water Mooring*, led by Professor Henrik Schmidt of the Ocean Engineering Department at MIT, combines

the Poseidon distributed oceanographic information system (refer to the Focused Research/Marine Centers section for a description of Poseidon) with a new instrumentation mooring for littoral environments to provide a unique facility for remote small-scale sensing capabilities for sediment characterization.

The second successful proposal in this thematic area represents an interesting melding of two separate activities—one being the continuing development of AUV technology and its applications; the other being the relatively new efforts to incorporate what we have developed as an Autonomous Surface Craft (ASC) for similar ocean related work. This proposal—*Autonomous Underwater Vehicle Navigation and Control Using an Autonomous Surface Craft*—originally proposed and led by Dr. James Bellingham, Principal Research Engineer and Manager of the MIT AUV Laboratory, will utilize the RF communication capabilities of a surface platform (in this case the ASC) and acoustic communication techniques to further the mission capabilities of the subsurface instrumentation platform (the AUV). Dr. Bellingham left MIT in 2000 to become Director of Engineering at the Monterey Bay Aquarium Research Institute (MBARI). Professor Schmidt is now the Principal Investigator for this research project.

Current efforts continue to focus on developing the key technologies for Autonomous Ocean Sampling Networks (AOSN). The MIT Sea Grant AUV Lab, sponsored by ONR and, in part, by NOAA through the Sea Grant College Program, led this multi-university research effort. The goal is to further our ability to carry out real-time oceanography over the long term, through the synergistic combination of AUVs, moorings, gliders, and satellites. Collaborators have included the Woods Hole Oceanographic Institution, the Institute of Ocean Sciences (Sidney, BC), Harvard University, the Scripps Institution of Oceanography, the University of Washington Applied Physics Lab, the Smithsonian Institution, MBARI and National Geographic Society. Professor Henrik Schmidt, MIT Department of Ocean Engineering, oversees this research area as Associate Director for Research. During the past year the day to day management and technical direction of the AUV team has passed from Jim Bellingham (Principal Research Engineer and AUV Lab Manager) to Justin Manley (Research Engineer) and continues with support from a number of Research Engineers, Visiting Engineers and Scientists, several Post-Doctoral Associates, Research Fellows, Research Specialists, and graduate students, as well as undergraduate students.

During 1998–2000 the AUV Lab focused its efforts on developing and demonstrating an Autonomous Ocean Sampling Network (AOSN). This effort was funded by ONR and involved numerous collaborators, notably the Woods Hole Oceanographic Institution (WHOI). While the MIT AUV Lab continued its vehicle development work, WHOI developed a mooring system that allowed the AUVs to dock for data downloading and battery recharging. Additional moorings and communications systems were developed that provided seamless interface, albeit with low bandwidth, between the AUVs and ship or shore controllers. The components and eventually the entire system were tested and demonstrated in several field experiments ranging from the Labrador Sea to Monterey Bay. This effort was officially concluded with a final field experiment in August 2000.

In parallel to the AOSN work, efforts were conducted to commercialize the MIT AUV technology and make it available to an audience beyond ocean science and research. The primary industrial application envisioned was in offshore oil services, notably exploration and survey. In 1997 Bluefin Robotics was incorporated. Market studies and business analysis led to the opening of Bluefin's design and manufacturing facility in 1999. This large growth of the company, understandably, led many of the AUV Lab's engineers to fully transition to the commercial arena and work for Bluefin. Over the same time period, Dr. James Bellingham, the AUV Lab Manager transitioned to a new position as Director of Engineering at the Monterey Bay Aquarium Research Institute (MBARI). Dr. Bellingham has established another AUV research group at MBARI that collaborates closely with MIT's AUV Lab and Bluefin Robotics.

Faced with a large departure of engineering talent and transitioning leadership the MIT AUV Lab has chosen to consolidate its efforts. AUV development and production will be left to Bluefin, located conveniently close to the AUV Lab. With a reduced staff, and a smaller fleet of vehicles, the MIT AUV Lab is now focused on enhancing AUV technologies and pushing the application of AUVs into new scientific areas. The primary area of future technology research is adapting the AOSN concept to yield a mobile network for ocean observation. The initial focus of AUVs is marine archaeology in deep water (below SCUBA limits).

AUV LABORATORY

During the July 1, 2000–June 30, 2001 period the AUV Lab has completed its transition phase and is poised to begin its new research agenda. The later half of 2000 was dedicated to completing the prior obligations of the lab to Professor Henrik Schmidt of the MIT Department of Ocean Engineering. Professor Schmidt required the support of the lab to complete his Generic Oceanographic Array Technology Sonar (GOATS) experiment. Consequently two MIT AUVs were dispatched to participate in the joint research effort with the NATO SACLANT Undersea Research Centre in La Spezia Italy. These AUVs and the MIT operations team joined two other AUV teams on the R/V Alliance and successfully completed the experiment. A dedicated report is available describing this intense field effort and the new technologies developed and deployed in GOATS 2000. At the end of the experiment one of the AUVs was decommissioned to provide spare parts for the other. The age of the Odyssey II platform and their long service life led to this reduction in fleet size to one operational vehicle.

During the first half of 2001 the MIT AUV Lab has focused on rebuilding its capabilities to be a leader in the autonomous vehicle field. The lab's Autonomous Surface Craft has been rebuilt and is now available to support AUV efforts. The lab's staffing has also stabilized. As of July 1, 2001 a full team is available. This team provides a spectrum of expertise to support future research. To complement this team, our spin-off company Bluefin Robotics is building a new AUV for the lab. MIT Staff have supported this new AUV construction from the outset and will be well equipped to deploy this new asset in future research efforts. Our close collaboration with Bluefin was also the highlight of our first major field deployment for 2001. During June, the MIT AUV Lab and a small team from Bluefin deployed two AUVs (the MIT Odyssey IIc and the Bluefin BPAUV) to Nisyros, Greece. The vehicles were used to collect sonar and video imagery of a shipwreck. The effort was hosted by EKTHE (the National Centre for Marine Research) and included the Greek marine archaeologists who first studied this wreck. In addition to EKTHE and MIT the Nisyros expedition was supported with the participation of the National Technical University of Athens (NTUA) and the Marine Archaeological Agency of Greece.

The MIT AUV Lab continues to host numerous UROP students and currently provides facilities and guidance for two graduate students (Course XIII and II). One UROP and one graduate student joined the lab on the Greek expedition.

TECHNOLOGY DEVELOPMENT AND MANAGEMENT FOR OCEAN USES

Lastly is a theme area we have traditionally included in our proposal solicitation that is deliberately broad in focus and title—Technology Development and Management for Ocean Uses. This theme area is meant to serve as an avenue for new and exciting ideas, and has, on occasion, yielded successful proposals that have evolved into continuing research theme areas. Our solicitation for new research to begin on March 1, 1997 did indeed result in a successful proposal in this theme area. This research—*Development of Particle Tracking Equipment for Flow Visualization Around Live, Unrestrained Fish*—led by Professor Michael Triantafyllou as Principal Investigator with Dr. Thomas Consi as Associate Investigator—both of the Department of Ocean Engineering was completed in February of 1999. This work followed a previous Sea Grant project that provided valuable insight as to how fish are able to display accelerations and sustained velocities that seem impossible from the viewpoints of available energy and conventional understanding of locomotion processes. Later research focused on better visualization and analysis of the flow of fluid through which live, unrestrained fish swim. This required development of sophisticated instrumentation and software to allow individual water particles to be illuminated and their motions precisely measured in space and time. The objective of this research was twofold: to better understand the mechanisms fish employ in their natural habitat is important to our appreciation of them as a species; secondly is the benefit to be gained in applying this knowledge to man-made vehicles to make better use of energy. Although this background was provided in last year's research summary it is referred to again because of the sound basis it has provided for current funded research projects and even more provocative potential research involving fish physiology. Attention should be drawn to the research being led by Professors Langer and Triantafyllou, completed in February of this year, and reported on elsewhere in this report.

In response to our solicitation for projects to begin in March of 1999 a proposal submitted by Professors Michael Triantafyllou of the Ocean Engineering Department and Professor Robert Langer of the Chemical Engineering Department—*Biomimetic Hull and Actuators for Fast-Maneuvering Vehicles*—received favorable reviews and was included in the Omnibus Proposal sent to the National Office in November of 1998. This project developed and tested multi-pressure sensors to detect vortical structures, and novel muscle-like actuators first using motors and then shape memory alloys to reproduce fish movement and control. The process is now underway to complete an evaluation of a synthetic skin structure with installed flow sensors on the hull of a robotic vehicle, the *Robotuna*, and study the use of such a biomimetic skin for use with a flexible hull form.

The following year Professor Triantafyllou again was successful in submitting a proposal—*Robotic Virtual Simulation Platform for Ship Maneuvering and Control*—that continues to evolve our understanding of what it takes to function in the ocean realm and the opportunities in robotic systems for ocean adaptability. The objectives of Professor Triantafyllou's most recent research in this area are to improve the maneuvering capability and marine safety of conventional merchant and naval ships by providing a robotic virtual testing platform, a combined simulation and experimental platform that can simulate realistically any prescribed unsteady ship motion, and test the effectiveness of novel control schemes. This project will reach completion in February 2002.

In our solicitation for new research in this theme area for projects to start in 2001 there were three successful proposals—all of which support and enhance the overall AUV program.

Professor John Leonard of the Ocean Engineering Department at MIT submitted a proposal to expand the autonomous navigation capabilities of the AUV. His proposal—*In-water Validation of Concurrent Mapping and Localization Using Sonar*—intends to pursue the in-water validation and performance analysis of a new algorithm for feature-based navigation of autonomous underwater vehicles using sonar. The goal of concurrent mapping and localization (CML) is to enable AUVs to build and maintain feature-based maps of the ocean environment from sonar data and to use these maps to navigate accurately for long duration missions over large areas of the ocean.

Propfessor David A. Mindell, Program in Science, Technology and Society at MIT, submitted a proposal that will apply autonomous robotic systems to an as yet untried task. *Precision Sub-bottom Profiling for Deep Water*

Archaeology will develop technology to collect high-resolution volumetric data below the sea floor for local areas such as shipwrecks, waste sites, or construction areas. It will also develop techniques for volumetric rendering of sub-bottom structures, similar to those used in other fields such as medical applications and geophysics. The specific proposed application is in the field of deep-water archaeology, but has applications for any area of geography that requires precise characterization of sediment layers over local areas.

Lastly, Professor Harold F. Hemond of the Department of Civil and Environmental Engineering at MIT submitted *Deployment of an Odyssey AUV Compatible In-Situ Mass Spectrometer.* Hemond proposes to field a membrane inlet mass spectrometer (MIMS) capable of operating autonomously, or on board an Odyssey class autonomous underwater vehicle (AUV) and providing the vehicle with a powerful new suite of measurement capabilities. The new instrument will be capable of real-time, in-situ, high-resolution measurement of dissolved gases and volatile organic compounds in the marine environment. The immediate objective of this project is a successful underwater demonstration of the functioning instrument packaged in a pressure sphere and compatible as an Odyssey payload.

These three new projects will reach completion in February 2003.

FOCUSED RESEARCH/MARINE CENTERS

The objective of the Focused Research/Marine Center concept is to plan and conduct research programs in collaboration with, and jointly sponsored by, industry and government agencies in order to attack major problems of broad interest to the marine community, and to foster industrial competitiveness by transferring the resulting technology to users. Focused Research projects have a six-year duration with the initial years heavily supported by Sea Grant Program funds. By the end of these multi-year projects the funding is expected to come entirely from non-Sea Grant sources.

Autonomous Underwater Vehicles: Basic Technologies, our second Focused Research project concluded in 1996. It served to develop robotic multi-use platforms, the Odyssey class of Autonomous Underwater Vehicle (AUV) for coastal as well as deep-ocean applications. Lessons learned from these vehicles have been incorporated into Odyssey II, which was built under the third Focused Research Program project, *Autonomous Underwater Vehicles: Scientific and Industrial Applications*, completed in July of last year. This Focused Research Project had also been supported as a Tactical Research Project of the National Sea Grant Office, entitled *Rapid Response to Seismic Activity on the Juan de Fuca Ridge.* A recent Focused Research project, *Development of Autonomous Surface Craft*, resulted in a prototype and field studies conducted in local waters. We have decided that this research effort more appropriately belongs within the broader research focus of the AUV program where the field infrastructure better exploits its anticipated capabilities.

The Autonomous Surface Craft (ASC) has concentrated on establishing a useful function in coastal survey and exploration activities. These efforts have mostly been confined to hydrographic surveys. Laboratory developments and fieldwork have produced a prototype system adequate for actual survey trials. These have produced both hardware and software components that provide a solid basis for the next stage of activity. A new mission for the ASC has been added. This involves using our prototype as a mobile communications station for our AOSN project.

As a consequence of the success of the Focused Research Programs that addressed AUV technologies and applications we have been able to capture additional funding. Today ONR and others support the AUV Laboratory at an annual rate of approximately $1.0 million. This illustrates the intent of our Focused Research theme area and further demonstrates how early funding of well thought out research areas can establish the soundness of more specific research and development objectives.

On August 1, 1996 the initial, first year work began on the fourth Focused Research/Marine Center, *Behavior of Capped Contaminated Sediments*, under the leadership of Senior Research Associate, Dr. E. Eric Adams of MIT. This research is intended to address theoretical analysis and field studies to determine the processes occurring in a capped contaminated sediment site. It follows a recently completed Focused Research Marine Center, *Contaminated Sediments in Boston Harbor*, led by former MIT Professor Keith Stolzenbach. A full history, results, and recommendations are now available in an MIT Sea Grant publication by the same title. This work will allow a fuller understanding of the site selection criteria, transport processes of contaminated material through the capping material and further aid in predicting benthic impacts. The University of Massachusetts/Boston and the School of Public Health, Harvard University are collaborators on this project.

A more recent Focused Research/Marine Center, *Poseidon: A Coastal Zone Management System via the World Wide Web*, initiated work in March of 1998. This project is a consequence of the high availability of raw ocean data, the various modeling approaches one can apply to large, multi-parameter data sets, and extensive uses such data-derived knowledge make possible (weather forecasting, fisheries management, environmental impacts, etc.). We have presented the vision supporting this research, and the results as they evolve at the Collegium symposia and workshops recently. There is a growing interest in this area as evidenced by the requests for more detailed information from our colleagues outside of MIT. This research program now enjoys the required financial support and can point to considerable endorsement. A companion proposal to the National Science Foundation has resulted in a $1.4 million award to implement and conduct field experiments. The field experiment is based on a series of observation system situation experiments (OSSEs) with the Harvard Ocean Prediction System for three regions of

the near coastal Northwest Atlantic which exhibit coastal upwelling events, spring and tidal mixing plankton blooms, and sub mesoscale eddy injection of nutrients into the upper ocean. The data streams for assimilation will include acoustic tomographic data and acoustical and optical backscatter data for biological variables.

The following year we again included the opportunity for new Focused Research proposals in our program solicitation for new research and educational proposals. We received one such proposal, *Distributed Observatories for the Coastal Environment* (Jim Bellingham, MIT AUV Lab. Manager). This project received favorable peer reviews and was included in our recent Omnibus Proposal to the National Office. With the departure of Dr. Bellingham the leadership of this project has been assigned to Professor Henrik Schmidt of the Ocean Engineering Department. The notion of distributed coastal observatories reflects the latest addition to our core research theme areas in that it is specifically oriented to the coastal regime and embodies an integrated approach to a real-time multi-disciplinary network for advanced study of a complex marine environment. This represents a unique opportunity to involve a network of advanced research tools such as the Autonomous Underwater Vehicle, in-situ observation platforms and remote sensing methods in a two-way telemetry system for use by many, possibly unrelated, researchers. This project is now in its third year with a completion date of February 2005.

Our most recent Focused Research project began this past March. *Biomimetic Rigid-Hull Vehicle with Flapping Foils for Enhanced Agility in the Surf Zone and Cluttered Environments* was submitted by Professor Michael Triantafyllou of the Ocean Engineering Department at MIT with Professor Dick Yue, also of the Ocean Engineering Department as the Co-principal Investigator. The long-term goal of this research is to develop a new class of rigid-hull autonomous underwater vehicles, best adapted to environments that require continuous maneuvering. The specific tasks are to design, build and test a biomimetic rigid-hull underwater vehicle utilizing flapping foils for its propulsion and maneuvering. Rigid-hull vehicles equipped with flapping foils can emulate some of the basic abilities of fish, including energy recovery, without requiring extensive hull actuation schemes. Fish and other animals that rely principally on flapping foils rather than hull flexure, such as trigger fish, which "flies" in water, the stingray that has long outstretching wings, and the penguin and sea lion, provide useful examples and opportunity for biomimetic application of unsteady flow control. This project began in March of this year and will be completed in February 2007.

NATIONAL STRATEGIC INITIATIVES

In the competition for new funded research as part of the 1999 National Strategic Initiative we were fortunate to receive favorable reviews for our proposal, *MIT Sea* Grant *Technology Program in Sea Scallop Mariculture,* with Professor Chrys Chryssostomidis and Cliff Goudey as co-principal investigators. The objectives of this program are to develop, refine and foster the commercialization of several innovative technologies needed by the Northeast sea scallop industry for its conversion to a sustainable, more economically viable industry. The technologies include improved harvesting systems for scallop seed and market-sized scallops, scallop bed monitoring, predator control and seed transport. This project enjoys significant collaboration with a number of experts and practitioners in the industry. The project began in March of 2000 and has an eighteen-month duration.

The proposal solicitation for National Strategic Initiatives during the 2000 yielded a number of interesting preliminary proposals, which were reviewed, and rank ordered by panels at the National Office of Sea Grant. Our program was fortunate to have received funding for two of the proposals submitted: *Environmental Marine Biotechnology: Development of Oligonucleotide Gene Chips as Sensors for Diverse Marine Pathogens* with Professor Martin Polz of the Civil and Environmental Engineering Department at MIT and Professor Ee Lin Lim, formerly associated with MIT and Professor Polz, and now with Temple University; and *Environmental Marine Biotechnology: Mussel Plasma Histidine-rich Glycoprotein (HRG) - Biomarker, Key to Metal Transport, Novel Natural Product* submitted by Professor William Robinson, Professor Manickam Sugumaran and Professor Gordon Wallace all of UMASS/Boston.

Professor Polz's proposed research addresses the early detection and monitoring of pathogens in coastal ecosystems using DNA microarrays and sophisticated quantitative polymerase chain reaction (PCR) analysis for enumerating gene copy number as a proxy for cell abundance. The ultimate goal of this research is to establish a technology to permit assessment of global distribution as well as the local variation of a variety of pathogenic populations in an efficient and cost-effective manner.

The research proposed by the UMASS/ Boston team led by Professor Robinson proposes to establish a biomarker of metal exposure and toxicity. Prior research by this team has succeeded in isolating and purifying histidine-rich glycoprotein (HRG) from an invertebrate—the *musselmytilus edulis*. This protein has been shown to strongly bind to metals such as cadmium. This proposed research involves advanced molecular/cellular biology and metal analytical techniques in the study. The team of three represents aquatic toxicology, molecular biology/protein biochemistry and inorganic geochemistry.

EDUCATION

Sea Grant is committed to providing learning opportunities for students, professionals, and the public. Support for graduate students is included in almost every research project. In addition, the program continues to provide major support for marine-related Undergraduate Research Opportunities Program (UROP) projects. Sea Grant UROP

directly provided $25,000. A substantial contribution from the Department of Ocean Engineering and the MIT UROP itself raised this to a total of $50,000. Ten UROPs were supported this year.

Completed in February of last year was a one-year educational project proposed by Cliff Goudey as Principal Investigator assisted by Brandy Moran as Associate Investigator—both members of the MIT Sea Grant Advisory staff. *Aquaculture Courses for Massachusetts High School Students* recognizes the need to view aquaculture in terms of its potential for economic benefits and the support necessary from a well-informed citizenry. The specific objectives of this project were to focus on the educational needs of the general public and the methods best used to provide it. Course offerings aimed at high school students that actually exposed them to a prototype marine finfish recirculating system located on Boston Harbor coupled with the development of course materials is seen as the essential first level of involvement in this activity.

As curriculum developed it was to be made available to local high schools through the contacts obtained from the New England Board of Higher Education, AQUA (the New England Aquaculture Educators Network) organizers, and the Boston National Historic Park special events coordinator. The focus of the curriculum, directed towards grades 6 through 12, is to develop a mock hatchery in their classroom. Course materials include instructions on the design and implementation of an aquaculture facility, routine maintenance, and laboratory procedures. This curriculum is currently being piloted at three schools: Essex Agricultural High School, Upper Cape Cod Technical High School, and the Sound School in Connecticut. Today the curriculum has been published through the MIT publication service as well as being available on the MIT Sea Grant Program web page. Our involvement at this stage is to assist the teachers as necessary.

Due to the extraordinary enthusiasm of those participating in this educational experiment and the resulting commitment from the three schools we have provided additional funding for Brandy Moran to develop *Grants for Education in Marine Science* as a seed project. This project solicited proposals from interested teachers to develop similar classroom curricula in marine sciences. We are able to support seven of the proposals submitted. At the end of the grant period we plan to host (in June 2002) a symposium to report the results and plan further activity in this educational area.

We again requested new educational proposals in our annual solicitation issued in 1999 for projects to begin in March of 2000. The Quincy Public Schools submitted an excellent proposal—*Develop and Implement Local Marine Curriculum for Quincy Public Schools*—in collaboration with a commercial partner, Photography by Michelson, Inc., owned by Mr. Robert Michelson. Previously our Program had supported Mr. Michelson with seed funding to develop and test a grade school classroom approach to marine science education. Michelson had established the efficacy of such an approach as evidenced by the strong endorsement his preliminary efforts enjoyed. The goals and objectives of this current project are: firstly to establish a clear and comprehensive awareness and understanding of the marine ecological environment for teachers and administrators; and secondly to develop and field test course units. A long-term goal of this project is to establish a process whereby high school, middle and elementary students continue their appreciation of the marine realm, and awareness of the career paths available to well educated and prepared young men and women. This two-year program with considerable participation by teachers is now in its second and final year.

In March of this year we had two new educational programs start. *Guide to Marine Hitchhikers*, submitted by Judy Pederson, Manager of the MITSG Center for Coastal Resources, is a one-year project extending Dr. Pederson's work in bringing much needed discipline to the problem of nonindigenous marine organisms spreading throughout the world. Certain vectors have long been recognized as mechanisms for transport of these nonindigenous species but with increased ocean traffic others are suspected and it is the intent of this project to address this issue. The project will focus on developing identification guides for the public to use, integrate the current efforts of several state agencies and others, and develop a database for collating information gathered.

The second educational program begun this year was submitted by John C. Buckley, a teacher with the Cohasset Middle-High School, *Moving Beyond "Just Another High School Research Project": Designing and Implementing Coastal Community Research that Meet Rigorous Professional Review Standards.* Mr. Buckley's proposal evolved out of an environmental education program, the Cohasset High School Summer Institute, partially supported by the Cohasset Education Foundation. The Summer Institute is focused on certain very timely concerns of the local community by engaging students in a program of involvement with the stewardship of the marine environment. This Sea Grant supported effort is designed to bring more scientific discipline to the program by instilling in the teachers and the students the need for well structured data taking and reporting. The participating students are expected to prepare reports along established scientific guidelines.

Every year the National Office of Sea Grant issues a solicitation for a program intended to fulfill its broad educational responsibilities and to strengthen ties between academia and industry- the Sea Grant Industry Fellowship. This program is available to graduate students who are pursuing research and development projects on topics of interest to a particular industry/company. A full partnership needs to be in place with a faculty advisor, the Sea Grant college or institute, the industry partner and, of course, the student. Professor Nicholas Patrikalakis as Principal Investigator, Douglas Webb, President of Webb Research Corp. and our Sea Grant program submitted a

proposal to involve Ocean Engineering graduate student Robert Damus in a two year project—*Sea Grant Industry Fellow: Communication Protocol and Technologies for Low-Power Untethered, Mobile Ocean Platforms.*

The communication infrastructure necessary for truly multi-level broad spatial and temporal ocean study must be approached at the protocol conceptual level. Actual physical links in such a system exist in vastly dissimilar realms. The measurement nodes, within and on the ocean, tend towards being both numerous and remote. Control and system maintenance exist in links that encompass the ocean surface in relatively close proximity to the deployed instrumentation but typically are expected to function autonomously. Use of the data, its processing and eventual dissemination of the information resulting from the data occurs at user sites that could be thousands of miles from the instrumentation. The cost of the instrumentation coupled with the expected number of users of the same instrumentation suite to investigate dissimilar ocean phenomena places a high premium on data availability, modeling convenience and immediate user interaction. This Industry Fellowship permitted Robert Damus to work closely with the Poseidon team led by Professor Patrikalakis while having the advantage of real-life hardware software engineering with the Webb Research activity. Mr. Damus' thesis, *The Remote Interaction, Planning and Visualization Tool,* was submitted in June of this year and points up very well the conceptual approach to this timely issue in ocean understanding. This proposal was successful and having begun in September of 1999 will run through August of 2001.

ADVISORY SERVICES AND TECHNOLOGY TRANSFER

The MIT Sea Grant Marine Industry Collegium promotes the active transfer of marine research and technology through the sponsorship of workshops, the distribution of publications and research reports, and direct interaction with members. Since 1975, the collegium has provided member organizations with the opportunity to attend several technical workshops and symposia per year. The collegium program collaborates with Draper Laboratories and other campus organizations in sponsoring symposia and workshops.

The most recent event in the collegium calendar occurred in October 2000—*Marine GIS Technology Conference/Workshop*—organized and hosted in collaboration with the Woods Hole office of the United States Geodetic Service (USGS). This two-day workshop was held in Providence, Rhode Island as a session of the FISH EXPO/Workboat Atlantic Conference and Trade Show. The collegium organized a program to focus on the use of geographic information systems (GIS) coupled with geographic positioning systems (GPS) to aid the commercial fishing industry in the Northeast. The program included presentations from Geoff Meaden, Senior Lecturer, Marine Fisheries GIS Unit, Department of Geography, Canterbury Christ Church University College, UK, and Professor Chuck Helsley, University of Hawaii, former Director of the Sea Grant Program in Hawaii.

To commemorate the retirement of Professor Koichi Masubuchi of MIT's Department of Ocean Engineering a festschrift was published based on an international conference held in his honor. Professor Masubuchi is a recognized authority on welding technology and has seen many of his former students move on to prominent positions in industry and academia. Along with the Sea Grant Collegium, sponsorship for the conference held in 1996 included the MIT Industrial Liaison Program and the American Welding Society. The festschrift, *New Horizons in Welding Fabrication: A Festschrift for Professor Koichi Masubuchi,* published in October 2000 is now available.

A new program to encourage and fund cooperative research between commercial fishermen and ocean researchers has been started with an FY2000 appropriation to the Northeast Consortium funded through the NOAA National Marine Fisheries Service with the assistance of New Hampshire's Senator Judd Gregg.

The Northeast Consortium is managed by the University of New Hampshire and overseen by Sea Grant member institutions in the northeast (New Hampshire, MIT and Maine) having a common goal of assisting the establishment of partnerships among stakeholders in the management of commercial fisheries in the Gulf of Maine. A number of projects have been funded as a result of a solicitation for proposals encouraging the use of commercial fishing vessels in ocean research, monitoring and management, education, and to conduct research leading to the development of selective fishing gear. MIT Sea Grant is the lead institution on two projects that began this June—*Adopt-a-Boat: Commercial Fishing Vessels in K–12 Education* and *The Development and Demonstration of a Whale-Free Buoy for Commercial Fishing.*

The Center for Fisheries Engineering Research (CFER) has strengthened its role in regional fisheries and aquaculture through several important initiatives and capacity building. Since its establishment in 1982, CFER project director Cliff Goudey has varied the emphasis depending on the needs of the fishing industry. Early topics included vessel safety, fuel efficiency, and fishing gear selectivity. More recently bycatch reduction, ecosystem effects of fishing, stock enhancement, and aquaculture have become more important.

CFER has established a marine finfish hatchery on Boston Harbor aimed at species and recirculating technology research and outreach. Aquaculture specialist Brandy Moran, hired to manage the facility and develop educational programs, continues to provide an on-going demonstration facility in support of our broad educational goals, and to promote the hatchery as a small-scale example of a potentially viable commercial activity. Brandy was assisted in her continuing work at our aquaculture hatchery in Charlestown by research technician Mark Watson during the past year.

CFER's collaborations with the fishing industry include: developing a low-impact scallop dredge; demonstrating sea scallop enhancement techniques in a nine-square-mile EEZ (Exclusive Economic Zone) site; and evaluating acoustic techniques for detecting the presence of right whales. As our part of a National Ocean Partnership Program (NOPP) funded project we are involved in the development of a system for fisheries data telemetry from commercial fishing vessels. Ken Ekstrom, an electronics/software specialist, continues to assist in this NOPP-funded project.

Collaborative work with the Massachusetts Aquaculture Coordinator, Scott Soares, has successfully identified the regulatory environment for aquaculture permitting in the Commonwealth. This activity was supported by a two-year funded project—*Aquaculture Permitting Guidelines for Massachusetts*—completed in February of last year. Draft permitting guidelines have been developed and are under review. Their production is scheduled to occur shortly together with an interactive web site. Test-case identification awaits the finalization of the guidelines.

The Center for Marine Social Sciences (CMSS) is actively pursuing its goal of applying advances in social sciences to help resolve marine-related issues and to contribute to policy development. CMSS continues to work with state and federal agencies and the public to identify and address local and regional needs in fisheries and coastal zone management. Marine advisory agent Madeleine Hall-Arber continues to track the social impact of new fisheries regulations and is currently working on a project to study fishing-dependent communities in New England. Dr. Hall-Arber works in an extensive advisory capacity with the New England Fisheries Management Council's Social Science Advisory Committee. She has served as the Social Science Editor for the American Fisheries Society's *Fisheries* journal. Hall-Arber continues as an active member of the Atlantic States Marine Fisheries Commission's Committee on Economic and Social Sciences, and as a member of the board of directors of the Women's Fisheries Network. Public education efforts continue through exhibits, participation in conferences and festivals, maintenance of an active e-mail discussion list, and articles in Commercial Fisheries News.

A new web page for Women's Fisheries Network is being developed with the participation of several of the members and the governing board. CMSS has been active in habitat issues, with the goal of helping the New England Fishery Management Council meet a mandate to identify and better manage Essential Fish Habitat. A book chapter and journal article describing the results of this activity will help further researchers' understanding of the significance of different scales of habitat observations to different fishing operations. In addition, Hall-Arber frequently serves as an informal advisor to students and journalists on social science and fisheries issues, and oversees the use of the Zebra Mussel Mania Traveling Trunk.

Zebra mussels, an aquatic species that invaded North America in 1988, have caused serious economic and environmental problems. They are rapidly spreading beyond the Great Lakes region into many waterways in the Midwest, and even into the Northeast (zebra mussels have already been found in the Connecticut River and Lake Champlain). MIT Sea Grant is tuning kids into zebra mussels and other exotic species through a new and exciting teaching aid called the Zebra Mussel Mania Traveling Trunk. Developed by Illinois-Indiana Sea Grant and the Illinois River Project with input from fifth- and sixth-grade teachers who contributed to curriculum development and related activities, the trunk is filled with ten hands-on activities that provide educators with tools to teach about the full range of problems associated with zebra mussels and other nonindigenous species. Use of the trunk encourages students to inquire and discover. What makes the trunk even more effective is the integration of other subjects, including math, English, social studies, and the arts.

Through experiments, games, stories, and a host of other interesting activities, students are able to understand problems caused by nonindigenous species and can learn how to become involved in solutions to prevent the spread of these species through community action projects.

The MIT Sea Grant Communications/Information Service, under the leadership of Andrea Cohen, produces outreach materials for a wide variety of consumers. This includes the newsletter, *Two if by Sea*, published jointly by the MIT and WHOI Sea Grant Programs. *Two if By Sea* highlights the research, advisory and outreach activities of Sea Grant programs in the Commonwealth, and provides the public with information about coastal and marine issues in the region. At Sea Grant Week 2001 held in March of this year *Two if by Sea* was given The People's Choice Award, an award given in recognition of excellence, by a vote of all members of the Sea Grant network.

Communications has revised the MITSG web site, making it more useful and interactive. We created a new comprehensive publications database, that will soon replace our current publications directory on the web. We also created a user-friendly on-line Citizen's Guide to Sources for Marine and Coastal Information in Massachusetts, and a web version of MITSG's aquaculture curriculum. We received funding for a second year for the Northeast Sea Grant web site; this site has been revamped. We have implemented changes so all our web pages meet federal accessibility guidelines.

Communications produces and distributes all of the program's technical reports and distributes and archives all program publications. We maintain a reference center with journals and books, which is available to the community for informational purposes. We also provide information to schools, businesses, government, citizens, media, the MIT community and others on a wide range of marine-related topics. This year we again collaborated with the New England Aquarium in planning the Environmental Writers' Festival.

The goal of the MITSG Center for Coastal Resources (MITSG CCR), under the leadership of Judy Pederson, is to serve as a link between scientific and technical research, and information, and the user community, such as state and federal agencies, local government, non-government organizations and citizens. The MITSG CCR provides outreach and educational activities in three general areas; water and sediment quality, marine bioinvasions and biodiversity, and impacts of fishing on communities. Specific activities have included publication of a set of abstracts for the *Conference on Dredged Material Management: Options and Environmental Concerns* held in December 2000. This publication, *Abstracts from the Conference on Dredged Material Management: Options and Environmental Concerns*, edited by Dr. Eric Adams, Department of Civil and Environmental Engineering, and Judy Pederson, includes abstracts covering a range of issues regarding the dredging and disposal of materials, environmental and safety concerns, and regulatory concerns. Dr. Pederson coauthored four of the abstracts. A volume of conference proceedings is planned for future publication.

MIT was the venue of a significant conference on invasive marine species held in January 1999. The papers presented are available as *Marine Bioinvasions, Proceedings of the First National Conference* published in February 2001.

In April 2001 the MIT Sea Grant Program participated in the *Second International Conference on Marine Bioinvasions* hosted by the Louisiana Sea Grant College Program at Louisiana State University. Judy Pederson was cochair of this conference with Marilyn O'Leary, compiler of the abstract booklet. The conference papers are being reviewed for publication later this year in the peer reviewed journal *Biological Invasions.*

The MITSG CCR maintains a web site at http://massbay.mit.edu that highlights research by the marine center on behavior of capped contaminated sediments, marine bioinvasions, and general linkages to other organizations, including those with data on water and sediment quality. Many of these projects are undertaken with state and federal agency support. Future activities include preparing a report on the recent *Rapid Assessment Survey of Fouling Organisms on Floating Docks*, convening a task force to prepare an *Aquatic Nuisance Species Management Plan for Massachusetts*, and summarizing the scientific and technical information from the Marine Center studies on the use of *Confined Aquatic Disposal Cells.*

The joint educational program established with the Massachusetts Maritime Academy (MMA) some twenty-five years ago has grown in terms of the educational/training needs it addresses and in its participation. During the past year MMA continued to expand a series of seminars oriented towards their traditional constituency of recreational and commercial users of coastal waters. Recent offerings have begun to address aquaculture and fisheries issues.

MMA's annual Saltwater Sportfishing Seminar is now in its 21st year and continues to draw large numbers of participants every year. Shellfish Farming Forum and Aquaculture Symposium events held during the 2000–2001 winter drew considerable interest. Recently the Massachusetts Shellfish Wardens Association requested the Sea Grant/MMA program to develop a training program for the more than 60 shellfish wardens in the Commonwealth to better prepare them for managing local town shellfish resources.

In addition, the MMA Fisheries Program has coordinated and participated in a variety of aquaculture workshops in conjunction with the Southeastern Massachusetts Aquaculture Center (SEMAC), Barnstable County Extension Service, and the Woods Hole Oceanographic Institution Sea Grant Program. These include the Scallop Workshop, and two Hazardous Analysis Critical Control Point (HACCP) workshops.

PROGRAM MANAGEMENT

The program director is Professor Chryssostomos Chryssostomidis, Department Head, Ocean Engineering. Associate directors for research are Professor Henrik Schmidt and Dr. E. Eric Adams. Richard Morris continues to serve as Executive Officer for the program. Timothy Downes continues as the program's Administrative Officer.

MIT Sea Grant administers the Doherty Professorship endowed by the Henry L. and Grace Doherty Foundation. In the competition for both of the past two years there were two outstanding nominees for consideration so much so that in each of these years both competitors were awarded the two-year Professorship.

In 2000 Assistant Professor Martin Polz of the Civil and Environmental Engineering Department submitted a proposal—*Quantitative Ecology of Harmful Microorganisms in Coastal, Marine Environments*—addressing the need to improve our ability to detect and characterize the causes of marine related illnesses and harmful algal blooms before they are manifested in major outbreaks. His research continues its focus on the use of quantitative polymerase chain reaction (PCR) techniques for detection and quantification of microbial populations. This research project concentrates the fieldwork in the New England waters.

The second Doherty Professorship for 2000 was awarded to Professor Nicholas Makris of the Ocean Engineering Department. His proposal for the Doherty award—*Monitoring Natural and Manmade Noise in Massachusetts Bay* —now in its second year, continues its study of whale vocalizations. This work is expected to lead into additional research involving a series of field experiments in high-resolution real-time spatial and temporal measurements of both natural and anthropogenic ocean noise. Stellwagen Bank, a National Marine Sanctuary with a variety of marine species, located in Massachusetts Bay, is both a convenient local for this fieldwork and a known habitat of

marine mammals including the nearly extinct northern right whale. This research attempts to establish a firmer analytical understanding in order to distinguish populations of marine life in terms of species identification, abundance and behavior. It, coupled with other anticipated research, will also determine the impact of the manmade ocean noise on various marine life—in particular the mammals present on the Bank, and in many cases threatened with further population declines.

Our call in 2001 for nominees for the Doherty Professorship in Ocean Utilization resulted in four proposals, two of which were again outstanding in their individual scores. Assistant Professor Julian Sachs of the Earth, Atmospheric and Planetary Sciences Department has proposed the development of two benchmark sea surface temperature (SST) records from the Southern Hemisphere. SST records for the last 150,000 years for the Northwest Atlantic are nearly complete. This record for the Northwest Atlantic taken in the Bermuda Rise shows high similarity to the isotope paleo-temperature record from a Greenland ice core. It remains unknown whether the large and very rapid SST fluctuations documented in the North Atlantic are confined to the Northern Hemisphere or are they associated with similar events in the Southern Hemisphere. Professor Sachs' research will go a long way to answer this question.

Professor Bernhardt Trout of the Department of Chemical Engineering is the other successful nominee for the Doherty Professorship in Ocean Utilization. His proposal—*Formation and Dissolution of CH4-Hydrates and CO_2-Hydrates in the Ocean*—involves two important materials in ocean utilization. CH_4-hydrates, practically ubiquitous on the ocean floor and in its seabed are potentially an enormous source of clean-burning fuel. CO_2-hydrates could be important in their ability to sequester and store CO_2 in the ocean. Both of these opportunities are being considered in pilot projects to explore their respective potential for commercial practicality.

The Doherty Professorships for Professors Sachs and Trout will run for two years.

More information about the Sea Grant College Program can be found online at http://web.mit.edu/seagrant/www/.

Chryssostomos Chryssostomides

TECHNOLOGY AND DEVELOPMENT PROGRAM

The Technology and Development Program's (TDP) primary mission is to provide a focus at MIT for research and education related to the role of technology in the socioeconomic development of newly industrialized nations. TDP works with other academic departments and research centers throughout MIT to:

- Promote an awareness of the relationship between science, technology, and development on the part of faculty and students at MIT;
- Provide a focal point for the technology and development activities of faculty, students, and visiting scholars interested in the field of technology and development;
- Assist the faculty, students, and staff of collaborating institutions in other countries to develop research and academic interests consistent with their national needs; and
- Serve as a contact for interested organizations outside MIT (government, academic, private sector) to access the Institute's resources and its knowledge of developing countries, particularly of their socio-economic and technological problems.

TDP carries out these objectives through research, academic programs, and contacts with international and national organizations that have an interest in broad areas of technology and development. In order to fully utilize available resources, the TDP is structured to interact with other academic departments and research centers throughout MIT.

CURRENT RESEARCH PROGRAMS

TDP currently has two major on-going programs.

TDP in Thailand collaborates in research and education with two major Thai Institutions: the Collaborative Program of Science and Technology with the National Science Technology and Development Agency of Thailand (NSTDA) and the Collaborative Program of Science and Technology with the King Mongkut University of Technology at Thonburi (KMUTT). These two programs are funded under an agreement with Suskapatana Foundation, and both started in 1996. Both activities are currently being continued at slower pace due to the economic hardship in Thailand. TDP continued its assistance to KMUTT in organizational of its research and academic programs and the start-up of a research center operating under the auspices of KMUTT. Professor Kevin Amaratunga continued his work on the Thailand Integrated Water Resource Management System Project.

Interaction between Professor Steven Lerman and NSTDA continued in the area of "Multi-Media Technology."

Since signing a multi-year Agreement with MUST-Ehsan Foundation in January 1997, TDP has been assisting the foundation with the establishment of the Malaysia University of Science and Technology (MUST). To Support the Establishment of the Malaysia University of Science and Technology, TDP and MUST have devoted their efforts to developing the academic programs at the graduate level in several engineering areas including Information Technology and Multi Media; Biochemcial and Biotechnology; Engineering Systems and Operations; and Transportation and Logistics; the research agenda focusing on infrastructure, information technology/multi-media, Biotechnology and Chemical Engineering, Advanced Materials, Manufacturing, and Energy and Environment; as well as working on institutional building activities, and promoting industrial and governmental collaboration and linkages. Due to economic hardship in Malaysia, TDP's activities have been carried out at a much slower pace. The government of Malaysia has funded MUST beginning this past May and MIT is negotiating with Motorola for the MIT portion of its funding for this endeavor which will be $25 million for five years.

FUTURE RESEARCH INITIATIVES

The Technology and Development Program continues discussions with appropriate institutions in Colombia, Egypt, and Kuwait.

In conjunction with ABT Associates TDP is exploring the possibility of establishing a Science and Technology Institute based graduate University in the Middle East most likely in Golan Heights. In Colombia, TDP and Mariano Ospina Foundation continue to work towards a formal proposal to establish an institute for research and education on large-scale infrastructure systems in Bogota. In Egypt, TDP continues its discussion with the office of the Prime Minister towards the establishment of a University similar to the Malaysia University of Science and Technology.

CURRENT EDUCATION INITIATIVES

The TDP-sponsored Middle East Program at MIT completed its twelfth year. The program (under the direction of Professor Nazli Choucri, TDP Associate Director) involves faculty from the Department of Political Science, Department of Economics, the History Faculty, the Department of Urban Studies and Planning, the Sloan School of Management, the Department of Civil and Environmental Engineering, the Science, Technology and Society Program, and the Aga Khan Program in Islamic Architecture. The program enables students with an interest in the Middle East to develop an expertise in the area in addition to their own academic fields of specialization; and it examines the processes of socio-economic change, technological development, political change, institutional development, capital flows, and business and investment patterns in the region.

In Malaysia TDP is working with MUST to promote the education of individuals to carry out the social and industrial development of Malaysia and is employing several mechanisms including: long-distance learning techniques; teaching of short courses in Malaysia; and faculty and student exchange.

ORGANIZATION

The TDP Director is Professor Fred Moavenzadeh who holds The James Mason Crafts Professorship, and Professor Nazli Choucri of the Department of Political Science is the Program's Associate Director. Patricia Vargas is the Assistant Director.

Fred Moavenzadeh

TECHNOLOGY LICENSING OFFICE

The mission of the Technology Licensing Office (TLO) is to facilitate the transfer to industry of technology from MIT, Lincoln Laboratory and the Whitehead Institute, and thereby to benefit the public good through the development and subsequent sale of commercial products. A secondary goal is to generate unrestricted funds to motivate inventors and to support research and education at MIT. The TLO staff of 29 (14 licensing professionals and 15 administrative and support personnel) are responsible for identifying marketable technologies, managing the patenting and copyrighting of these technologies, finding licensees to develop the technologies and negotiating licenses.

This was an unusually successful year financially for the Technology Licensing Office, with income of $82.1 million, of which $55.6 million was cash-in of equity (from two companies).

We consummated 77 new technology licenses and 48 new option agreements (a total of 125 agreements). Twenty-six of these agreements were to new startup companies. We currently have almost 600 active licensees. We also granted 59 end-use software licenses and signed up 10 new trademark licensees in FY2000.

With over 600 active licenses in house and about 160 startup companies extant (with equity in about 60 of them), we can expect that royalty streams will continue to mature and companies will reach equity liquidity, but the timing is unpredictable. Studies by others have shown that the average university license that matures into products takes eight years to do so. The stream of new inventions continues at over 400 per year (446 in this fiscal year), refilling the pipeline.

TLO staff are also active contributors to student activities at MIT. These include judging in the "50K" student business plan contest, guest lectures on patents and licensing in a number of Engineering, HST and Sloan School courses, both undergraduate and graduate, and "open door coaching" for students thinking of starting a business, whether through an MIT license or not.

Members of the TLO are actively involved in disseminating our technology transfer and entrepreneurship processes and practices to University of Cambridge and other United Kingdom universities as part of the CMI program. Staff exchanges between the MIT TLO and the University of Cambridge tech transfer office are underway as part of this project.

Senior TLO staff also served pro bono on the boards or senior committees of a number of national, state, and local entrepreneurial and tech transfer organizations.

They have served usually pro bono as advisors to over a dozen university or governmental technology transfer offices in a number of countries and to the International AIDS Vaccine Initiative, in addition to hosting literally dozens of visits from other such organizations and corresponding company departments.

More information about the Technology Licensing Office can be found online at http://web.mit.edu/tlo/www/.

Lita Nelsen

DIRECTOR, LIBRARIES

Research universities operate in the world of ideas, concepts, and knowledge. These intellectual intangibles are both an essential raw material of the educational process, and a fundamental outcome of university research. The new knowledge that emerges from institutions such as MIT has traditionally been reviewed, structured, and shared across disciplines and institutions in the form of "packages" of information. These packages, which historically took the familiar form of books and journals, have been critical to the university's ability to organize and use knowledge in a comprehensible, efficient framework. It is the mission of university libraries to acquire, organize, and maintain these information packages, whatever form they take, for the benefit of current and future faculty and students.

Like its peers, MIT is both a consumer and a producer of packaged information. The Institute relies heavily on the ready availability of such organized information as a fundamental building block of education and research. Needless to say, MIT also contributes significantly to the stream of publications that flows from universities. MIT faculty take for granted, and well they should, the ability of their Libraries to capture and preserve their intellectual contributions and to collaborate with them to select and manage the many other diverse forms of information that contribute daily to MIT's excellence in teaching and research.

Equally important but somewhat less visible are the Libraries' additional responsibilities for instructing students in the effective use of these information resources, and of preserving important information resources from one generation to the next. No other aspect of the academy or of society attends to this particular set of responsibilities. Across disciplines and over time, libraries have captured, made available, and preserved advances in knowledge for the benefit of their faculty and society, and they have instructed each subsequent generation of students in the productive use of information resources. Indeed, the magnitude of this traditional value is manifested in the ubiquitous and familiar presence of research libraries across the landscape of higher education.

As electronic analogs of print publications began to emerge in significant numbers in the mid to late 1990's, this underlying framework for efficient, persistent knowledge management faded from view, and libraries' traditional values of selection, organization, instruction, and preservation became increasingly disconnected from the digitized items that libraries served over campus networks. Not surprisingly, speculation concerning the future of academic research libraries arose as faculty learned to appreciate the convenience of networked digital resources. Despite libraries' preeminent status as early, enthusiastic adopters of information technology and computer applications, libraries found to their dismay that they had become the symbol of an academic business model many wished to change.

The more popular scenarios of those years assumed that print books and journals would become first obsolete, then irrelevant, as all useful information would be rapidly digitized. Scholars would communicate with one another directly through the Internet, eliminating the middlemen of publishers and libraries. The need for faculty and students to physically visit any educational facilities, including classrooms and libraries, would disappear; replaced by web-based services and door to door (or desktop to desktop) delivery of needed information. Rank and position would no longer apply within academic disciplines, as traditional scholarly publishing went the way of the typewriter and the mimeograph.

Today the obstacles to change appear far more serious, and the opportunities for rapid transformation far more limited. The collapse of digital-only publishing reminds us that underlying value propositions still apply to the creation, communication, and preservation of new knowledge. The growing burden of email brings home the impracticality of one-on-one communication strategies and reinforces the efficiencies of "packaged" scholarly communication. The relentless pressure to extend the legal status of tangible property to intangible ideas forebodes a future based on ubiquitous transaction fees, and threatens the very notion of "fair use" in higher education. Long-term digital archiving remains a hugely complicated and expensive alternative to traditional print on paper, and no political/economic system for archiving has yet emerged that inspires sufficient confidence or trust.

While we remain optimistic that the system can and will change for the better, we are now far wiser about speed with which change might occur. We appreciate the enduring efficiencies of packaged information (despite the flaws), the complexity of the environment in which change must occur, and the strength and determination of the forces that stand in opposition to a vision of more freely accessible information. And with the full promise of digital information still poised tantalizingly on the horizon, the MIT Libraries now have five years of practical experience with the best the electronic environment has to offer.

In the "doing" of digital information the Libraries have a far more realistic understanding of the advantages, costs and obstacles associated with fulfilling the digital promise. For example, the MIT Libraries now "rent" access to some 8,000 electronic journals and well over 200 databases. Reluctantly, we have begun to rely on information packages for which there is no guaranteed archive, at MIT or anywhere, and which will disappear completely the moment MIT stops paying. Meanwhile, walk-in visits to the Libraries increased, the cost of library material continues to rise at a rate higher than that of inflation, and the MIT Libraries' physical collections continue to grow by about 40,000 linear shelf feet per year.

On the other hand, the ground-breaking DSpace project made significant progress during FY2001. DSpace is an innovative research partnership between Hewlett Packard and the MIT Libraries to build a durable digital repository for MIT faculty intellectual output. The project hold the promise of enabling faculty to manage their own material in the furtherance of education and research, and has vastly increased our understanding of the challenges of developing a digital repository that can begin to approach to the advantages of paper archives.

PROGRESS TOWARD MASTER PLAN OBJECTIVES

In these times of challenge and uncertainty, the MIT Libraries five-year master plan, developed with broad participation and considerable care in 1999, has continued to be an effective blueprint for innovation and change. Progress was made in FY2001 in virtually every strategic direction identified in the plan.

In FY2001 the libraries progressed in their aim to excel at providing rapid, easy, and precise access to high quality information for education and research at MIT in the following ways:

- Network-based access to the Libraries' core collections was expanded again in 2001.
- Access to materials was enhanced through expanded use of the web and via on-going classification and collection management projects.
- Service to students and faculty was improved through new training programs and innovative service models.

Progress toward the goal of ensuring that library spaces and operations facilitate intellectual life on campus was made in the following ways:

- Group study rooms were introduced in several facilities.
- Wireless network access was introduced in many locations.
- Planning for a new Preservation Services Center was initiated.

The libraries strive to be a leader among academic research institutions in the use of applied library technology. During FY2001:

- The DSpace project continued to break new ground in the development of digital repositories.
- The integrated library management system selected for implementation provides for robust self-service and resource linking functionality.

Both the E-Reserves project and Ask Us Live reference service were innovative experiments in network-based information service.

These accomplishments reflect an extraordinary level of focus on the part of the MIT Libraries' staff, and speak to the continued relevance of the Libraries' five-year plan. Yet these were not the only efforts and initiatives of the MIT Libraries during FY2001. As the attached directorate reports attest, the year was exhilarating, challenging, and occasionally nerve-wracking.

STRATEGIC PRIORITIES FOR THE YEAR

The overall goals for the year were set at the Libraries' annual planning retreat in June 2000, at which time the expanded leadership team of the Libraries agreed upon the strategic priorities the Libraries would collectively pursue during FY2001. Commitments were made to implement a new, more functional Barton integrated library system; to employ the principles of usability testing systematically across the Libraries' web pages; to continue to work toward upgraded, contemporary Libraries' facilities; to continue the important experimental work of the DSpace project; to explore tools for enhanced navigation of information resources; and (with Academic Computing and Information Systems) to increase delivery of Libraries' services over MIT's network.

The staff of the Libraries were Herculean in their commitment to achieving these goals. As daunting as the commitments list may appear, the staff accomplished all this and more. Among the highlights of the year were the following successes:

- Installation of a new integrated library system on an accelerated schedule;
- Unveiling of the Libraries' completely new, redesigned, and usability-tested web site;
- Introduction of a pilot project to test web-based reference services, "Ask Us Live";
- Launching of BELL: Buried E-Journal Locator List, a service that allows users to find full-text articles within journals that are only accessible within aggregated databases;
- Restructuring the roster of Public Services positions to create two new forward-looking positions—a GIS Specialist, to support MIT's growing need for geo-spatial expertise; and a Data Services Librarian, to enhance student and faculty access to numeric social sciences data;
- Development of a new Document Services capability to deliver electronic articles directly to requestors' desktops;
- Increasing electronic resources to the level of nearly 25 percent of both titles and serial expenditures;
- Continuation (year three of five) of a multi-year project to make records of important historical library material available in the Barton online catalog;
- Initiation of a preservation survey and of a plan to catalog two of the Institute's most important special collections;

- Introduction of a table-of-contents service within Barton to link bibliographic records to the table of contents of many recently published books;
- Implementation of cost-recovery printing in Libraries' reading rooms;
- Planning for compact shelving to be installed in the basement of Building 14;
- Grateful acceptance of an anonymous gift to establish a badly-needed, long-desired Preservation Services Laboratory; and
- Grateful acknowledgement of numerous large and small gifts in furtherance of the Libraries mission and capital campaign goals.

NOTABLE ACTIVITIES

In April 2001 the Libraries were pleased to welcome the MIT Libraries Visiting Committee for their biannual meeting. The meeting convened for two full days, rather than the customary day and a half, because of the rich and full agenda. Special attention was paid to providing the committee with opportunities to interact with Libraries staff, to talk directly with faculty, especially the Faculty Committee on the Library System, and to engage one-on-one with graduate and undergraduate students of the Institute. Attendance was strong, and the discussions were energetic and stimulating for staff and committee members alike. As always, the Libraries benefited greatly from the knowledgeable insights of this committed group of leaders.

Throughout the year, the Faculty Committee on the Library System continued to provide strong leadership within the Institute for improved Libraries finances and facilities. The Chairman of the Faculty Committee, Professor John Lienhard, worked diligently to focus the work of the committee on a targeted set of needs, and to keep the value of the Libraries, and the challenges they face, in the forefront of the academic agenda of the Institute.

The MIT Libraries were also very pleased to continue their individual and collective involvement with a number of the Institute's important planning initiatives. Staff were active in such Institute undertakings as the Council on Educational Technology, planning for the OpenCourseware Initiative, the Information Technology Architecture Group, and in discussions with the Open Knowledge Infrastructure planning effort. The Director of Libraries was honored to have been invited to join the SHASS Ad Hoc Committee on the Humanities Library.

SENIOR STAFF ADDITIONS

A number of important staff positions were filled during FY2001. The Libraries celebrated the hiring of MJ Miller, the first full-time Director of Resource Development in the history of the MIT Libraries. In short order her enthusiastic professionalism and early successes reinforced the merits of this decision. The subsequent rise in interest in the Libraries' giving opportunities has been most welcome, and her skills and experience greatly appreciated.

Also warmly welcomed in FY2001 were the considerable experience and depth provided by James L. Mullins. Jim joined the Libraries mid-year as Assistant Director for Administrative Services. Jim's prior experience included a wide range of contemporary library management challenges. His in-depth understanding of facilities improvements proved critical to the Libraries' ability to keep their space planning and building improvement projects on schedule.

The DSpace Project, an initiative of MIT's partnership with Hewlett-Packard, was successful in its goal to hire its full contingent of key staff. A prototype version of the repository was developed and project staff began work toward the early adopter phase of the project. Once DSpace was on schedule for early adopters, two Sloan School graduates, Mary Barton and Julie Harford, were retained to conduct related business model research proposed to and funded by the Andrew W. Mellon Foundation.

CONCLUSION

The full measure of the accomplishments of FY2001 will be found in the directorate reports attached to this brief overview. The exceptional achievements of the MIT Libraries during FY2001 are a true reflection of the commitment and professionalism of the staff of these legendary libraries. MIT is fortunate indeed to benefit from the teamwork, dedication, and enthusiasm of so many accomplished individuals. Individually and collectively, it is they who have made the Libraries the exciting, forward-looking organization it is today. MIT Libraries staff are a splendid example of the capacity of intelligent and committed individuals to pursue a worthy goal and, even in a year as busy as FY2001, manage to have fun along the way.

As always, the MIT Libraries are deeply indebted to many groups and individuals for their achievements. This is particularly true of the year just past. The Faculty Committee on the Library System, chaired by Professor John Lienhard, worked tirelessly to improve the finances and facilities of the Libraries. The MIT Libraries Visiting Committee provided invaluable insights to our work and mission. The Information Systems Department and the Academic Computing group were essential in their support for our initiatives. At one time or another, every member of Academic Council provided a helping hand when needed. For these friends and the many others not named specifically, the MIT Libraries extend their thanks and sincere appreciation.

More information about the MIT Libraries can be found online at http://libraries.mit.edu/.

Ann J. Wolpert

PUBLIC SERVICES

The MIT Libraries have long provided a wealth of services in support of MIT's educational and research programs. Inherent in this role has been the need to continuously add and adjust services to ensure that they meet the information needs of faculty, students, researchers, and staff as their needs evolve over time and as technology changes the ways information is delivered. Now that a significant amount of information is available on the web in the form of electronic journals and books, members of the MIT community are beginning to expect that library services themselves will be modified to provide enhanced assistance to users who rarely or never physically visit the library facilities. During FY2001 much of the focus of the MIT Libraries' Public Service units has been on ways to add new services while retaining and enhancing the most important traditional in-person services for our user community.

We are now in the second year of operation under the set of Strategic Directions identified in FY2000, with significant progress to report in many areas. The staff have done an admirable job carrying out a number of high-visibility systemwide initiatives while also paying close attention to the needs of their local units. In some instances this dichotomy of system needs competing with local needs has created some tension, but through careful discussion and management, the issues have been resolved with the Libraries overall and the individual units having made major steps forward. Many of the projects the Public Services units have carried out have included use of new systems and digital tools, and the staff are to be commended for learning how to use these most effectively to deliver the highest quality services to the MIT community.

ACROSS THE LIBRARY SYSTEM

This year's most impressive achievement has been the planning, development, and implementation of the Ex Libris Aleph integrated library system to replace the GEAC Advance system. Circulation, reference, and processing staff across the libraries dedicated substantial portions of their time and energy to this task and were successful in getting the new system is now ready to be turned on shortly after the start of FY2002. Public Services staff took leadership roles in fleshing out new functionality in the circulation system, developing an online catalog that is easy to understand and navigate, and creating a web tutorial and other instructional aids to help members of the MIT community learn the new system. All Public Services staff contributed to this major undertaking either by participating in one of the working groups or by staying in their units to fill in behind the staff working on Aleph. The timeframe for implementing Aleph was ambitious, but the staff used all of their skills to create a new system that will provide users with improved, easier access to both primary and secondary scholarly resources and to personal information about their own use of library materials. Work will continue in the coming year to expand the range of features offered and to implement functionality that was not deemed essential for day one.

A second major project in which Public Services staff played a lead role was the complete redesign of the MIT Libraries' web site. Work on this began in FY2000 and continued throughout FY2001. The goals of the project were

- to select and present quality resources;
- to organize information in ways that are useful to the MIT community;
- to educate the MIT community in the effective use of information;
- to promote the MIT Libraries and our services;
- to promote user self-sufficiency; and
- to promote user feedback and communication with the Libraries.

The overall organization of the web site changed substantially from the earlier version. Instead of presenting a virtual presence that mimics the physical realities of the disparate units within the MIT Libraries, the web content was reorganized to make it easier for users to find information regardless of location. New categories were established for the homepage, and usability tests were conducted at each stage of the design development to be sure the new site would be logical and intuitive for users. A graphic design firm was engaged to create a new look for the reworked content, and the new user-centered site was put up in test mode early in the spring. After receiving feedback from users, the design was finalized and the new web site officially launched in June 2001. It was listed as a spotlight on the MIT homepage shortly after its debut and has received positive comments from faculty, students, and staff. There is more still to be done to expand the information available from the divisional and branch libraries and other departments, but we are very proud of the new design and functionality.

A third high visibility undertaking during FY2001 has been the establishment of a pilot project to deliver real-time reference assistance over the web. As earlier annual reports have documented, in the past decade, the MIT Libraries have licensed access to a wide array of resources in electronic formats that can be accessed from offices, laboratories, and dormitories as well as in the various libraries. However, until this year, there has been no electronic counterpart to the expert research assistance available from trained librarians. As an experiment in providing digital reference service, during FY2001 the Libraries negotiated an agreement with LSSI, Inc., a vendor of library products and services, to test a new reference product. Using this software, librarians are able to "co-browse" the web alongside remote users to help them refine their searches and locate databases and e-journals of interest to them, and librarians can also "push" webpages out to a user's computer. The pilot digital reference service, "Ask Us Live," was offered for 10 hours each week for the second half of the year and has been very well received by the MIT community. Planning is underway to expand on the pilot project during FY2002, and we have also begun

discussions about how this kind of electronic reference assistance will impact our traditional in-person reference and information services in the long run.

ON THE LOCAL SCENE

Progress on Strategic Direction 1—Providing Easy Access to High Quality Information

In addition to the sometimes-overwhelming systemwide projects described above and in other sections of this report, each of the individual library units within the Public Services directorate took real strides to enhance access to information. The Institute Archives received a sizable and important collection of records from the MIT Planning Office including files, maps, and blueprints. The Office of the Executive Vice President provided funding for expedited processing, and project staff were hired to sort and organize the materials. By the end of the year the Planning Office records had been organized into 37 different collections, which have now been placed in preservation quality containers to preserve them for the future, and the contents have been listed and described so that they will be easily accessible. The Institute Archives also collaborated with staff in Bibliographic Access Services to prepare a plan for cataloging the rare books owned by the Libraries so that there will be records for these materials in the Barton catalog. For some time these valuable resources have been somewhat invisible to members of the community, but work has now begun to enhance access to the items in this collection.

In Document Services the focus was on delivering more materials to users' desktops. Building on the popular electronic thesis delivery service established last year, the department implemented "Web-Docs," a fee-based electronic article desktop delivery service. Faculty in Electrical Engineering and Computer Science were the first to try the service, but after getting a favorable response, the service was quickly expanded to the entire MIT community and eventually to outside customers as well. Web-Docs usage has been smaller than hoped, so Document Services expects to promote its visibility in FY2002.

In other areas, significant progress has been made in preparing the Libraries to enhance access to numeric social sciences data and geospatial data. Library staff members participated in the I/S Geospatial Data Discovery Project through which agreement was reached on a joint GIS service program with staffing coming from both the Libraries and I/S. We were successful in reallocating salary monies within Public Services to create a full-time Geographic Information Specialist headquartered in Rotch Library. A highly qualified individual has been recruited to fill this position, and she will assume her position early in FY2002. A new Data Services Librarian has also been hired, and she will begin in August 2002. We are looking forward to having the staff in place at last to develop and promote widespread use of data and GIS services to faculty and students around the Institute.

Many staff in the Libraries devoted a portion of their attention to expanding our outreach and instructional activities. In particular, the user groups of librarians formed to focus on segments of the MIT population arranged new activities to help strengthen the ties to our user communities. One example of this new focus is the Undergraduate User Group, which visited students in one of the dormitories and arranged for a library presence on Registration Day. Another example is the Graduate Student User Group, which started a regular column on library news and topics in the Graduate Student Newsletter, hosted a welcoming reception for graduate students in the Barker Engineering Library at the beginning of fall semester, and engaged the Graduate Student Council in discussion about library space planning, programs, and services. The establishment of these mechanisms for communicating with students has planted seeds that will continue to bear fruit in coming years.

Progress on Strategic Direction II—Improving Library Spaces and Operations

This year saw the continuation of major space planning efforts across the Libraries as well as smaller modifications and improvements in individual units. Programmatic planning for a combined Engineering and Science Library was a primary focus, and a team of staff worked with an architectural consultant to develop a program statement. As this planning was underway, concerns surfaced about the future of the Humanities Library in Building 14. A committee comprised of several SHASS faculty, the Director of Libraries, and the Head of the Humanities Library was formed at the behest of the Chancellor. This group worked through the spring to better understand the information needs and expectations of humanists for a Humanities Library, and they expect to complete a report early in FY2002. One positive by-product of this has been the renewed focus by Humanities faculty on the library, which will be very helpful as we plan for the future.

Planning also continued for the Libraries' Information Kiosk to be located on the Student Street in the Stata Center. Members of the Libraries staff participated in brainstorming sessions with representative students to get a clear sense of how this space could best be used to benefit the students. Working with I/S staff, plans have now been tentatively laid to use this space to experiment with a virtual presence system that would enable students in the Information Kiosk to see and interact with librarians at a remote location. We also hope to try such technology-enabled experiments as a flexible polymer video display fabric as a means of creating banners to promote resources, activities, and events on the street.

A third major planning project that emerged and gained energy during the year centered around the future location of the Sloan School and the possibility of either building a new Dewey Library as part of the Sloan complex or having Dewey take over additional space in the Hermann Building which would be renovated for this purpose. Several Dewey Library staff participated in Sloan planning meetings and conducted brainstorming sessions with the

rest of the professional staff. A vision of Dewey Library as an intellectual crossroads for Sloan, Economics, and Political Science students and faculty has blossomed and will be carried forward in future planning discussions.

One of the highlights of the year was the September dedication of the new Aeronautics/Astronautics laboratory space in Building 33, which includes a new state-of-the-art Aero/Astro Library. As with any building project, some punch-list issues have taken time to resolve, but the Libraries are pleased to have this wonderful facility in such close proximity to student workspaces. Judging by the comments students have made, they are enjoying the new space and equipment as much as the library staff are.

The Dewey Library was the first library at MIT to receive a wireless communications infrastructure when the Sloan School installed a wireless communications infrastructure in all their facilities. Wireless access to the network is now available on the first and second floors in Dewey and will make it easier for students with laptops to connect while they do their library research and study. Rotch Library also added wireless capability on the entry level and look forward to its implementation and expansion to other floors in the coming year.

Although not as grand in scale as the projects just mentioned, several other achievements in the space category are worthy of note. One of the most frequently voiced requests the Libraries receive is for additional group study spaces that will allow small groups of students to work on joint projects and to prepare for presentations. During the past year, by repurposing other spaces, one group study space was created in the Barker Engineering Library, four group study spaces were created in Dewey Library, and four group study spaces were identified in Rotch Library. Individual study carrels were added in the Science Library and have already seen heavy use. These carrels provide more privacy than the large tables in the Science reading room and enhance the study environment for many students who seek peace and quiet and no distractions while they work.

Other projects to modify spaces in Building 14 were also planned and started, but these are described in other sections of the Libraries annual report and do not need to be repeated here.

SERVICE EVOLUTION

As the year progressed, a number of significant changes and trends occurred in services the Libraries have provided. Foremost among these was the decision to phase out the Computerized Literature Search Services. This service had been very valuable to a small, loyal cadre of users, but the costs of continuing to provide the service in light of demands for other new programs resulted in a plan to close the service. After the initial decision was made in September, the CLSS librarian announced her impending retirement, and the service closed officially in February 2001. Since then there have been a handful of requests for in-depth database searching, but these have been referred to existing fee-based services in other academic research libraries when appropriate.

The Libraries continue to be used as placed to study, user materials, and get assistance, although these use patterns are changing. Doorcount statistics dropped several years ago, but this year they rebounded. Circulation continues to hold fairly steady, but in-house use has dropped off, probably due to the growth in the number of materials available in digital formats. The trends in reference transactions vary depending on location—in the Archives, reference activity increased 14 percent while many of the other libraries showed a slight decline in the number of reference queries. On the other hand, email ("Ask Us") and digital reference ("Ask Us Live") services grew substantially and now account for roughly 10 percent of all reference transactions. Interlibrary borrowing requests to obtain items needed by MIT faculty, students, and researchers, plateaued, but we have grown concerned that the number of items requested through ILB but owned at MIT increased dramatically from less than 5 percent to 14 percent. Reasons for this change will be explored in the next several months.

One other significant change in service philosophy was the introduction of fee-based printing from public computers. Over the past several years the Libraries have witnessed a decline in the number of photocopies made (in FY2001 copy activity has decreased by 25 percent) while the number of pages printed has steadily increased. With no charging mechanism in place, there was no incentive for users to exercise any restraint, and, as a result, costs to the Libraries were rising rapidly. Rather than risking further expenditures from the Libraries' tight budget, we decided to implement the UnipriNT management system, which uses the copy-card system to charge users for each page printed from electronic databases and other web resources. The system was installed first in Dewey Library as a test and then throughout the other library locations. After a two-month break-in period in which the system was operational but printing continued to be free, charging was turned on in late February. A thorough public relations campaign was launched to educate the community about the reasons for taking this step, and we have been pleased that there have been few complaints since the program began.

NOTABLE STAFF ACCOMPLISHMENTS

Many of the staff in Public Services made contributions to the profession in a variety of ways too numerous to list. Among the highlights are the following.

- Pat Flanagan, Deborah Helman, Lisa Horowitz, and Sarah Wenzel made a presentation on digital reference services at the 2001 ACRL national conference.
- Catherine Friedman has served a one-year term as President of the Reference and User Services Association, a division of the American Library Association.

- Steven Gass was one of two U.S. librarians invited to make presentations at a Japanese XML workshop for electronic journals sponsored by the Japan Science and Technology Corporation in March 2001.
- Nicole Hennig published an article entitled "Card sorting usability tests of the MIT Libraries' web site: categories from the users' point of view."
- Megan Sniffin-Marinoff was elected to the Council of the Society of American Archivists.
- Theresa Tobin has served a one-year term as Chair of the Women's Studies Section of the Association of College and Research Libraries.

LOOKING FORWARD: CHALLENGES FOR THE FUTURE

One of the serious problems that continues to plague Public Service units is the high rate of staff turnover. During the past year more than 20 staff left their positions, and nearly the same number of new staff were hired. While we are pleased at our ability to attract excellent people, this level of turnover creates problems in moving new initiatives forward and handling the routine work in each of the units. Dewey Library has been particularly hard hit; over the past two years 70 percent of their staff have turned over. The turnover problem has been compounded in FY2001 by a number of staff going on extended sick leaves that kept them out of work for months. The staffing situation is one that will bear further discussion and scrutiny in the next year.

Overall, the Public Services units have accomplished a great deal in meeting the information needs of the MIT community. They have pressed forward and made laudable progress on large systemwide projects, and they have continued to mold and shape local services as user needs have evolved. MIT is fortunate to have such an able staff. Without the contributions of each and every staff member, we could not have accomplished all that we have. To our users, thank you for your support, and, to the staff, bravo!

Virginia Steel

COLLECTION SERVICES

Fiscal year 2001 was dominated by efforts related to implementing a new library management system, Ex Libris' ALEPH. Significant progress in many other initiatives was also realized. Acquisition and cataloging of digital resources continued to challenge our staff, as did the management of print and other physical collections.

3RD BARTON IMPLEMENTATION

The implementation of a new library management system is a major endeavor. This year's processes required significant time, attention, critical thinking, and planning skill from a broad cross-section of Libraries' staff. Almost all Collections Services staff were involved, some spending over 50 percent of their time in related activities. Library management systems are highly integrated. The ALEPH system will facilitate functions related to acquisition, receipt and check-in of materials, fund account management, cataloging of materials and database management, circulation of materials, and the generation of the on-line public catalog. It will enable workflow connections between these functions, as well as on-line user services based on the nearly one million bibliographic records and associated authorities records that were migrated. In addition, it will mesh with external records systems, such as those of commercial vendors of library materials, vendors of bibliographic data, MIT central accounting, and MIT student information services.

The inventory of activities listed below paints only the broadest picture of the effort required:

- Selection of system—The Information Technology Librarian was instrumental in the coordination of the vendor demonstrations during the summer months. Many staff participated in follow-up analysis of system functionality in relation to defined requirements.
- Negotiation of contract terms—A short seven-month implementation timeline after contract completion added a significant stress factor.
- Preparatory database cleanup—This included deletion of records for materials no longer held, correction of irregularities in call numbers and dates, review and deletion of orders and invoices that were no longer active, clean-up of vendor records, and resolution of data conflicts to ensure system number matching.
- System configuration—This included determination of indexing tables and logical bases, character sorting and equivalencies, basic system settings and mapping data. Mapping serials data was especially complex since it was the first time that data has been migrated.
- Data migration—The Database Management Librarian assisted the Systems Manager in monitoring the data migration processes, which required round-the-clock vigilance.
- Testing—Iterative testing of data was required after initial migration and through a series of requested revisions. Testing was complicated by system instability and downtime at critical points, as well as delays in the vendor deliverables. Financial data migration was particularly "dirty" and required intense analysis and correction. The record loader had not yet been delivered at fiscal year-end; it is expected in early FY2002 and still requires testing.
- Training—Two monograph catalogers and one serials cataloger were three of a total of five instructors responsible for teaching beginning and advanced GUI OPAC searching to over 200 staff members. Specific work-related training continues in all work units and in cross-departmental sessions such as serials check-in.
- Workflow and work process definition—Due to the accelerated implementation, delays in deliverables, and complexity of analyzing data migration issues, insufficient time was available for planning effective work flow

and work processes. This planning will continue during the first months of FY2002 and will be informed by a growing working knowledge of the system. However, an effort was undertaken to work with ExLibris and our major book wholesale vendor to create a suitable record loader for ordering on the vendor's system and loading vendor bibliographic records into our Library Management System. Since our staffing level is based on this automated record loading, it was critical to be able to extend it into the new environment.

MANAGEMENT OF DIGITAL INFORMATION RESOURCES

Acquisition

The Libraries continue to provide access to digital information resources at an accelerating rate. This year we were able to make significant progress in our goal of providing a critical mass of relevant and significant electronic journals. Early in the year, we purchased access to Elsevier's *Science Direct*, providing 560 full text e-journals. Later in the year, we purchased access to *Kluwer Online*, including almost 800 titles. Other major purchases in support of the Engineering and Science community included JSTOR *General Science Collection*, five full-text titles from *Jane's*, *Access Science* (the web version of McGraw Hill *Encyclopedia of Science and Technology*), an upgrade to *SciFinder Scholar* (*Chemical Abstracts* online) to allow for more simultaneous users, 24-hour access, and substructure searching, and additional user permissions for *Web of Science* (the ISI databases). Major purchases in support of Humanities and the Social Sciences included the *Oxford English Dictionary on the Web*, the *Euromonitor Global Market Information Database*, *Women's Resources International*, 300 full-text psychology journals from *ProQuest*, *Grove's Dictionary of Music*, *Index to Current Urban Documents*, *cq.com* (to access congressional information), and *BNA Environmental Library*.

Between fiscal years 1997 and 2001, the percent of serial titles purchased (i.e. titles which require ongoing commitment of funds such as journal subscriptions) which were electronic resources increased from 0.7 percent to 24 percent; the percent of serial dollars spent on electronic resources increased from 4 percent to 25 percent. At the end of FY2000, the Libraries' provided access to 2,046 electronic journals and 210 electronic databases. At the end of FY2001, these numbers were 3,295 and 274 respectively.

Managing this growing array of electronic resources requires additional staff time. This year we shifted a part-time position into the Digital Resources Unit to support activities related to the licensing of these products as well as problem resolution. There is an increasing need to monitor and resolve access problems, which may be related to the provider's server, to IP filtering, or to something as mundane as an unresolved renewal problem. We reached a threshold this year, due to our growing list of supported products, where resolving access problems is as time-consuming as efforts related to licensing new products.

Cataloging

ERESCAT, an ad hoc group of staff from Collection Services as well as the Web Manager from Public Services, was created to grapple with policy issues related to extending limited cataloging staff resources to covering digital products as well as traditional information resources. An interim report will be shared within the Libraries during the summer months. The report recognizes the current necessity of continuing to maintain both Barton and Vera as tools to manage and provide access to digital resources. It defines the unique characteristics of digital resources that impact cataloging decisions, and the factors influencing whether a digital product will be included in Barton. It recognizes the current period as one of experimentation, during which the cataloging staff will aggressively pursue pragmatic strategies for cataloging e-resources on a product-by-product basis, as well as for managing and deleting records.

Several experimental efforts were undertaken during this year. For one product, *Books 24 x 7*, records provided by the vendor were loaded into our catalog. This required resolution of a few electronic data problems as well as creating a special loader script. For another product, the publications of the Association of Computing Machinery, staff utilized OCLC's CORC metadata harvesting software to create brief records for all of the conference proceedings. In addition, we have subscribed to OCLC's Bibliographic Notification Service so that we will receive full MARC records as they become available in the OCLC database. In the case of the *IEEE Explore* package of resources, we have undertaken a cooperative cataloging initiative with the University of California, San Diego. Within this agreement, MIT will contribute cataloging records for the IEE colloquia publications, and the records will be incorporated into the OCLC WorldCat Collection Set for use by other libraries. These flexible alternatives to traditional cataloging models are a credit to the creativity of catalog department managers and staff and signal a cultural shift that will increase success in providing effective bibliographic access in an environment of rapid change.

Provision of title level access to the contents of "aggregator databases," collections of information resources that do not have stable content, is still a challenge. At the end of the year, Serials Solutions, the best option to date, was purchased to provide access to approximately 8,000 fulltext titles in this category via Vera.

Preservation

One of the major unresolved issues related to electronic information resources is their preservation for use by future generations of scholars. D-Space, the joint MIT Libraries/Hewlett Packard initiative, will have an impact in this area. In addition, this year the Libraries presented a proposal to the Andrew W. Mellon Foundation to plan for a multi-year project to archive "dynamic e-journals", scholarly web sites such as the MIT Press' *Cognet*. These sites

represent the leading edge of changes in publishing no longer bound to conventions needed in the print environment. It is important to find a way to make these more fully realized e-journals available to future scholars. In January, the Mellon Foundation announced that it would fund this planning project, and in April, a Project Planner was hired. We expect to submit a proposal to Mellon in early calendar year 2002 for a multi-year implementation project.

MANAGEMENT OF PRINT INFORMATION RESOURCES

During this year of extremely intense systems planning and accelerated activity related to the management of digital information resources, considerable effort was also directed toward the management of our traditional library collections.

Collections Housing

In our continuing efforts to reduce the need to send collections to off-site storage, the spring months were devoted to planning for a CRSP funded compact shelving installation in the basement of Building 14. Engineering studies carried out as part of the Shepley Bulfinch feasibility study of Building 14 indicated which area of the basement has sufficient floor loading capacity for this installation. Early in the calendar year, the Institute assigned a project manager, and contracts for the work were awarded to Acme Office Systems and William B. Meyer, Inc., Library Relocation Division. With a goal of using this opportunity to improve the usability of collections throughout Building 14, a working group consisting of public services and collections staff was convened to plan collections arrangement. We plan to move all bound journals and bound theses from the Science Library to the basement, and to move all books classed in Q from the basement to the Science Library. Because of the juxtaposition of compact shelving with stationery shelving, it is necessary to rearrange the entire basement collection at the end of the project. The group has planned an arrangement that will improve the usability of the collections and provide adequate growth in each area. The collections and shelving will also be cleaned. The project began immediately after final exams in May. Journals from the compact shelving area were moved to the Humanities and Science reading rooms for the construction period.

The compact shelving planning group decided to try to move any materials that we would want to move from Hayden Basement to storage in the foreseeable future at this time, so that when the collections are rearranged they will be stable enough not to require significant shifts for several years. Staff spent many hours preparing volumes for moves to the Retrospective Collection and the Harvard Depository. Approximately 21,000 volumes will have been moved before the collections are rearranged. It will take at least six months to arrange and shelve these materials in the RSC; we anticipate being able to provide less than the usual level of service in the interim period.

FY2001 was the last year in a three-year project to accelerate moves of materials to storage in order to provide adequate on-site shelving for growing collections. Our goal for this year was to move 20,000 volumes from Barker Engineering Library. Over 17,000 volumes were moved before we had to temporarily suspend these moves in order to carry out the large Hayden basement moves. In addition, however over 40,000 other volumes were moved to storage from various locations in the library system, significantly surpassing our required standard of annually removing volumes equal to new acquisitions (45,000-50,000 volumes per year).

Significant Achievements Related to Improving Bibliographic Access

This was the third year of a five-year project to provide bibliographic access to the Dewey Decimal Collection, housed in the RSC. An additional 12,000 monograph titles (for a total to date of approximately 37,000 titles) were cataloged this year through contractual arrangement with OCLC. In addition, serials cataloging staff continued to provide in-house cataloging for serial and journal titles from the same DDC areas.

A staff shift in Bibliographic Access Services at the end of last year resulted in the reassignment of a cataloger to rare books cataloging. This individual attended two week-long classes at the Rare Book School of the University of Virginia and began to catalog materials from the Rotch Limited Access collection. An ad hoc group of cataloging, preservation, and archives staff was convened to recommend handling, marking, security and cataloging procedures. A report was approved by Steering Committee at the end of the year, and the cataloging of the rare book collections will begin in July 2001. The large collection formerly referred to as Rare is being renamed as two collections: MIT Founders Collection and MIT Legacy Collection. Survey data related to physical condition of volumes cataloged will be entered into a database for future reference.

In an effort to expand capacity to catalog maps, staff in the Copy Based Cataloging unit were trained to catalog maps with available cataloging copy. Lindgren Library's remaining uncataloged maps were cataloged, with the exception of non-Roman language materials. Still needing cataloging is a large map collection in the Rotch Library.

Review of processes to expedite supply of theses to Document Services customers resulted in identification and elimination of redundant efforts in the entire workflow chain. In order to be able to respond effectively to submission of electronic-only theses, Passport macros were created that streamline cataloging processes.

We contracted with Blackwell North America to receive upgrades for Barton records from their Table of Contents Enrichment Service. This will provide a deeper level of access to our book collections.

Significant Achievements Related to Acquisitions
Acquisitions staff were happy to welcome a new Financial Administrator and Assistant Director for Administrative Services after several months of interim arrangements. After years of "desire," the Libraries and central accounting implemented a data feed of payment information, which will result in faster payment of invoices and closer synchronization of MIT payment information and the Libraries' system (now ALEPH) payment information. Significant effort went into completing all year end ordering, receiving, and invoicing on Geac Advance before the end of the fiscal year, which was accelerated by the closing down of the Geac system.

The Head of Serials Acquisitions gave a well-attended and well-received presentation of the Federal Depository Library Program for distribution of government documents. The Dewey Library committed to a six-month time frame for completing its review of documents item selections, which will feed into our efforts to complete cataloging of government document serials.

The Head of Serials Acquisitions and two processing supervisors presented a claiming workshop for all check in and claiming staff.

Gifts-in-kind contributed about 10 percent of our monograph acquisitions and included a few very special additions to the collections: *Pennyroyal Caxton Bible*, illustrated by Barry Moser, *Wenyuange siku quanshu dianzi ban*, a complete library of four branches of literature on CD-Rom, and an epic Irish poem, *The Tain,* by Thomas Kinsella, translated into Spanish, which was delivered in person by the Mexican consulate.

Significant Achievements Related to Preservation and Collections Management
In December, the Libraries learned of a gift from an anonymous donor for the purpose of establishing a Preservation Center. In January, the Libraries submitted a successful CRSP proposal for a space change to accommodate this center. An architect and a project planner have been assigned, and the work will begin in January of 2002.

The Retrospective Collection staff prepared a proposal for *A New Service Model for the Retrospective Collection.* It was reviewed by Steering Committee in January and implementation planning is now underway to fulfill the following goals: develop an article delivery service, implement a notification service related to status of requests, limit the hours the RSC is open to the public, require a referral letter for non-MIT users, permit direct user access to the stacks only under limited conditions, develop a communications plan, and prepare a list of action items for facility improvements. A part-time position was moved from Serials and Acquisitions Services to the RSC to provide staffing for the document delivery initiative.

SUMMARY
The staff responded to the many demands and uncertainties of this year with tremendous energy, commitment, and intelligence. The MIT Libraries, including Collection Services, have always been blessed with highly capable staff members. This year demonstrated a melding into a highly capable organization.

Carol Fleishauer

ADMINISTRATIVE SERVICES
Administrative Services (AS) supports the MIT Libraries' mission and goals in the areas of Budget and Financial, Delivery Services, Facilities/Operations and Procurement, Payroll and Staff Records, and Personnel. It would not be an overstatement to say that the services provided by AS are fundamental to the operation of the Libraries —recognizing its role in providing the infrastructure necessary to support the Libraries' Staff in their provision of services and resources to the users of the Libraries and their responsibilities to the Institute. The goal of AS is to work behind the scenes to insure that staff are recruited, hired, retained, remunerated and provided growth opportunities consistent with MIT policies in well planned and maintained facilities, at present and in the future.

To integrate the services provided by Administrative Services more directly into the decision making processing of the Libraries, it was decided at the beginning of FY2001 to create the position of Assistant Director for Administration who would administer AS and would serve on the Steering Committee of the Libraries. With the retirement of the Head of Administrative Services, a review of the role of Administrative Services was undertaken. It was determined that a department that included all administrative services would be logical, to this end, the human resources function that had been split between AS and the Director's Office was integrated as one area within Administrative Services. It was also determined that the larger role of facility planning, short and long term, would become a responsibility of AS (with coordination and collaboration with Public and Collection Services).

To fill this new position a search was undertaken for a person to serve as Assistant Director for Administration. The Search Committee conducted a national search during the summer of 2000. The search was successful and an appointment was made January 1, 2001.

BUDGET AND FINANCIAL
A major transition took place during this past year. The retirement of the AS Department Head after many years of service, along with the resignation of the Business Services Administrator several months later, could have seriously hampered the efficiency and effectiveness of AS. However, on an interim basis, the Associate Director for

Collections Services and a staff accountant on loan from the Controller's Accounting Office provided able leadership for AS. During the fall, a successful search was completed and the vacant Financial Administrator position was filled effective January 1, 2001.

Concurrent with this appointment came the implementation of the new integrated on-line library system. Not only does the new system integrate all facets of accessing research information for the MIT Libraries, it is also the financial procurement and auditing system for the acquisition of library resources, both print and digital products. The Financial Administrator worked closely with colleagues in SAS to insure that all present and historic records were correctly transferred and that an accurate and efficient process to procure and pay for library acquisitions is in place.

DELIVERY SERVICES

The work involved in moving materials throughout the MIT Libraries as well as distributing all mail and other delivery services requires not only coordination and cooperation of all involved, it requires strong backs. The amount of library materials moved throughout the Libraries' has been steadily increasing. With the shift of more and more of the Libraries' holdings into storage, either at RSC or the Harvard Depository, the requests and return of materials from these sites places additional demands upon Delivery Services (DSO). It can only be expected that as more materials are sent to storage these demands and expectations will increase.

Many factors come into play as materials are moved throughout the Libraries'—not the least of which is renovation of facilities, creating difficulties in accessing loading docks or delivery sites. Coupled with this is the disruption caused by street repairs or right of way work, making it difficult to reach some delivery points. The DSO Staff has been resourceful and creative in adjusting to these challenges. This spring, the DSO Staff began to record the number of materials distributed through its operations. In future annual reports, it will be possible to compare past and present use, as well as project demand for Delivery Services in upcoming years.

FACILITIES AND OPERATIONS

FY2001 saw significant steps taken on several critical facility issues, including: short term maintenance, building renovation and upgrades, and a major effort to identify long term facility planning.

During the summer of 2000, construction of a fire pipeline into Building 14 was begun. Preliminary meetings were held to discuss the various phases and its impact on operations. Piping was brought through the basement of Building 14 into two newly cored penetrations to the exterior. This work affected various units of the Libraries, including Preservation Services, Document Services, Music Library, and Delivery Services.

Building 14 has long been subject to roof leaks, especially in 14S. After a particularly bad leak in February, an intensive effort undertaken by the Department of Facilities identified several problems with drainage and cracks in the roof and floor of the penthouse. Work was completed during spring to correct the problems, and at the end of the FY2001, the issues seem to have been resolved.

The Dewey Library Staff identified several safety issues with the basement of Building E53, including emergency signs and lighting. This was brought to the attention the Department of Facilities who installed the necessary signs and lights. To freshen the appearance of the Dewey Library, new drapes were installed to replace ones hung when the building was built in the 1960s.

The installation of a series of panels depicting the history of the School of Humanities, Arts, and Social Sciences (SHASS) caused a major refurbishing to take place along the corridor in 14N. This was accomplished by collaboration and coordination between the Libraries and SHASS. The result is a much brighter and attractive corridor in close proximity to the entrance to the Humanities and Science Libraries in Hayden.

Aeronautics and Astronautics Library

FY2001 saw the completion of the work on the Aero/Astro Library. Begun during FY2000, the complete re-thinking and re-designing of this library has enabled it to be more fully integrated into the teaching and learning processes of the departments it serves. Located adjacent to laboratories, it is easily accessible to students and faculty as their need for information arises. The space was designed to accommodate print materials, access to digital resources, study space and staff work areas. Although less square footage than the older facility, the use of compact shelving and excellent design has made the space more effective in meeting its mission.

CRSP FY2001 Project

In order to house as many print materials as possible within Building 14, it was determined that installation of compact shelving (moveable shelving that reduces space dedicated to aisles), should be investigated for the basement of Building 14. After an engineering study determined that only a limited portion of the floor had the strength to support compact shelving, a CRSP proposal was funded in FY2001 that provided for the installation of compact shelving in this section at the center of the basement. While the capacity was not what had been hoped, the new compact shelving is expected to extend the shelving capacity for up to five more years. The project began after the end of classes in May 2001 and is underway during the summer of 2001. For further discussion of this important

project, especially the impact upon collection shelving and storage, please see the Annual Report of Collection Services.

A second project was also funded as part of the FY2001 CRSP projects, which is the renovation of Hayden Libraries entrance. This project is expected to include the integration of the Reserve Book Room into the immediate area and to provide a 24-hour study room. Due to planning delays and the review being undertaken by Shepley, Bulfinch, Richardson, and Abbot during FY2001 of Building 14 (see below) that could have impinged on this project, it was decided to delay this project until FY02.

CRSP Proposals FY2002
The libraries responded to the call for FY2002 CRSP proposals by submitting two projects. The MIT Libraries had been given an anonymous gift to support the creation of a Preservation Services Laboratory. The gift was to purchase the necessary equipment and cover some staff costs. The Preservation Services Laboratory will eventually become part of an integrated Preservation Services Center, which will house both the Preservation Services Laboratory as well as a new digital projects laboratory. Funding is now being sought for this companion Digital Projects Laboratory. In order to house the additional equipment and staff necessary for such a center, the Libraries had to identify space adjacent to the site of the current Preservation unit. The concurrent impact required a juggling of space between the original Preservation unit, the Library Systems Office and the Institute Archives. In spring 2001 the Libraries were informed that this project had received CRSP support. Planning will begin during summer 2001, with the project to begin during IAP, January 2002.

Long Term Facility Planning
During FY2001 a major effort was begun to assess the long-term facility needs of the MIT Libraries. Since the MIT Libraries are housed in facilities that basically have not changed since the 1960s with the completion of the Dewey Library, the ability of the Libraries to house collections and provide services consistent with the needs and expectations of students and faculty of MIT at the beginning of the 21st century is seriously compromised.

The FY2000 Libraries Master Plan, prepared with the assistance of Shepley Bulfinch (SBRA) architectural firm, called for combining the Engineering and Science Libraries into one facility. In FY2001, the Libraries again contracted with Shepley Bulfinch to assist with a Feasibility Study of Building 14 to discover its potential for housing a combined engineering and science library as well as the central services currently housed there. Their report was received in May 2001. It concluded "that an expanded Building 14 would not effectively accommodate the programs for both the Science and Engineering Library and the Library Central Services."

The report includes the following components: analysis of existing building conditions, analysis of compliance with building codes; program for a Science and Engineering Library; program for the Libraries' Central Services; proposed architectural diagram; preliminary phasing and project cost estimates. Even with the proposed aggressive and expensive expansion plan, the Building 14 library facilities would fall 20 percent short of program needs for a combined Science and Engineering Library and Central Library Services. However, the feasibility study illuminated a number of opportunities for improving library facilities in Building 14 and will continue to inform viable alternatives for functional program accommodation. It has already been of great use in planning the compact shelving project for the basement and in providing reliable data for continued space planning.

PAYROLL AND STAFF RECORDS
At the invitation of Financial Systems Services, the Staff Administrator participated in the development and testing of an alternate platform on the web for journal voucher preparation. Voucher employees hired for projects or unfilled positions increased from 12 in 1999–2000 to 40 in 2000–2001. In order for Library Council members to track voucher payroll expenditures, a form was created. To facilitate the links between Human Resources and the Libraries Payroll, the Staff Administrator assumed responsibility for correcting errors and/or resolving problems with payroll status.

PERSONNEL
Recuitment
Recruitment and search activities in the MIT Libraries continued to receive a high level of energy and attention in FY2001. The Libraries filled 13 administrative and professional staff positions as a result of serious searches. In addition to traditional librarian positions, these newly filled vacancies included a Library Technology Consultant, an Analyst/Programmer, a GIS and Statistics Specialist, a Financial Administrator, and several non-librarian supervisor positions. Also included in this total were the search to fill a Libraries' Steering Committee position, Assistant Director for Administration, and a newly developed position in the Libraries, that of Director of Development. Two additional administrative staff level positions were filled through the waiving of the serious search process and internal promotions of highly qualified support staff (Library Technology Consultant and Supervisor, Dewey and Humanities Processing) and another was filled through the upgrade of a support staff position (to Facilities and Operations Administrator), again creating an opportunity for an internal promotion.

The Libraries also conducted a record number of serious searches to fill Sponsored Research Staff positions this year. Grants from Hewlett-Packard and the Mellon Foundation for the DSpace Project and for the E-Journals Archiving Project have provided funding to fill several "hot skill" positions. The Libraries now have four Sponsored

Research Staff associated with these exciting projects, a Project Planner for E-Journals Archiving, and for the DSpace Project—a Systems Curator and two Senior Marketing Development Managers.

The largest number of positions filled throughout FY2001, however, was among support staff. A total of 32 positions were filled this year, which represents approximately one-third of the Libraries' support staff headcount. A competitive local job market has clearly taken its toll on the Libraries' ability to attract and retain library assistants. Salary requirements for many of these incoming library assistants have created internal equity issues, which will require analysis and attention over the next year.

The recruitment of student assistants in the Libraries remains a challenge. There are many other jobs on and off campus that offer better wages and more meaningful career opportunities for students. In order for many library departments to carry out routine, basic services, it has become necessary to hire temporary hourly/casual employees. While this strategy has proven effective in some cases, it can only be for a limited period of time and does not allow the Libraries to establish valuable relationships with the student community.

Retention

The Libraries recorded 26 terminations this year—nine from the administrative staff and 15 from the support staff. Of the nine departing administrative staff members, two retired and two left the workforce for family reasons. Exit interviews with other departing staff members show salary still to be one factor impacting the decision to leave the MIT Libraries. Another of the factors cited for leaving the Libraries is the perception of a heavy burden on limited staff. A clear message from several of these departing staff members was that the Libraries do not have enough staff to accomplish the innovative things they want to do and still maintain effective patron services.

The Libraries have seen a significant impact of the special allocation provided in FY2001 for market adjustments to librarian salaries. These salary increases have been noted by staff as recognition on the part of the Institute of their value to the teaching and research programs of MIT. These salary increases have also improved the MIT Libraries' competitive position among our peers.

According to the Association of Research Libraries' (ARL) recent salary survey (reporting 1999–2000 data), MIT ranked 23rd of 122 in Average Professional Salary. This figure is up from 39th last year. Among our true peer institutions (22) in this group, the MIT Libraries have risen in the standings from 17th to 12th. It is worth noting, however, that seven of the peer institutions out-ranking MIT are located in the northeast. (See Table 1 below.)

Table 1. MIT Ranks 12th Among Peer Group and Below Group Average in Salary Ranking

	FY2000 Average Professional Salary	FY2001 Average Professional Salary	Peer Group Average Professional Salary
UC-Berkeley	$63,250	$68,414	$56,213
Stanford	$63,727	$67,221	$56,213
UCLA	$63,233	$65,174	$56,213
Columbia	$58,392	$60,862	$56,213
USC	$57,038	$58,511	$56,213
UConn	$56,121	$58,468	$56,213
Princeton	$57,144	$58,102	$56,213
UMass Amherst	$53,417	$57,199	$56,213
Harvard	$55,899	$56,732	$56,213
Dartmouth	$54,719	$56,541	$56,213
Yale	$53,017	$56,488	$56,213
MIT	$50,052	$54,846	$56,213
UWisc.-Madison	$47,773	$54,367	$56,213
UMichigan	$51,543	$53,921	$56,213
Brown	$51,916	$53,233	$56,213
UVirginia	$52,335	$52,058	$56,213
Northwestern	$50,290	$51,915	$56,213
Duke	$49,117	$51,384	$56,213
UT-Austin	$49,588	$50,888	$56,213
GaTech	$48,321	$50,318	$56,213
UPenn	$49,243	$50,303	$56,213
Purdue	$48,425	$49,751	$56,213

MIT has improved its standing in Beginning Professional Salary as well, up from 37th to 15th within the entire ARL group, and up from 14th to 8th among our true peer group. Again, a number of the peer institutions outranking MIT are New England institutions, including Harvard.

Statistics support that MIT's ranking among its peer institutions, both for beginning and average professional salaries, has substantially improved as a result of the Institute's attention to enhancing the MIT Libraries' position in the competitive marketplace. These statistics also indicate that continued attention to librarian salaries will further improve MIT's competitive edge against other academic library peers such as Harvard, Princeton, Stanford, and the UC system.

Two of the fifteen support staff departures were due to retirement. While salary is an issue in attracting new support staff it does not appear to be a direct factor in support staff departures. A significant number of last year's support staff terminations can be attributed to job advancement or career pursuit. It is worth noting that five (one-third) of the 15 positions vacated this year were by employees who had been with the Libraries for one year or less, however, several of these were attributable to performance issues.

Administrative Services' staff has begun collaborating with the Compensation Office to analyze market data and assess salaries of both administrative and support staff in the Libraries. In addition to reviewing salary data, the Libraries' have provided compensation staff with information regarding recruitment and retention challenges for library staff in the form of a "Strategic Workforce Planning" document.

Rewards and Recognition
By all accounts the Libraries' implementation of the Institute's Rewards and Recognition initiative was a success. Operating under a significant time constraint, the Libraries' design team developed programs for both the Infinite Mile Award and the Spot Award during the first half of the year. On June 27 a luncheon was held for library staff to celebrate the contributions of all staff members during what has been a very demanding year. The luncheon was followed by a celebratory and even moving presentation of the Infinite Mile Awards. Within each of the award categories (Innovation and Creativity; Communication and Collaboration; Results, Productivity, and Outcome; and Community), four individuals and four teams—a total of 25 staff members—received a certificate of appreciation and a cash award.

Both programs were explicitly designed around peer-recognition. The impressive number of persuasive and heart-felt nominations received for the Infinite Mile Award was truly gratifying and reflected the great respect and appreciation library staff members have for one another. The Spot Award Program, a monthly drawing from a pool of submitted "thank you's," kicked off at the June 27th award event. The program was well received and thank you's have already begun rolling in.

Affirmative Action
It is discouraging to note the decrease in the Libraries' minority representation among the administrative staff. With the departure of two Asian females since July 2000, the percentage of underrepresented minorities on the administrative staff is now at three percent. One of the librarians took a position at the Harvard Business School and the other elected to devote more time to her young family. In both cases the MIT Libraries developed and supported creative strategies to try to retain these individuals, including sponsorship in the Association of Research Libraries Leadership and Career Development Program for underrepresented minority librarians in the former case, and the creation of a job share arrangement in the latter. Though ultimately unsuccessful, both strategies enabled us to retain these librarians in our employ for a longer period of time.

Despite diligent recruitment efforts in the serious search process we have been able to identify only a very few minority applicants in our candidate pools. This is a trend experienced by academic and research libraries across the country, as the percentage of minority library school students remains low. Of that small portion of minority students, few are electing to pursue librarianship in the academic setting. The highly competitive job market for librarians in general as well as MIT's need for librarians with sci/tech backgrounds are added complications. Recruitment for the majority of librarian positions involves a full national search where positions are posted with various American Library Association minority groups. Full or limited local searches are conducted to fill non-librarian, professional positions and a local affirmative action source, such as The Bay State Banner, is used. Each applicant pool is diligently reviewed to identify any possible minority applicants, and to interview those applicants who meet the qualifications. Of the searches conducted this year, a total of six minority candidates were interviewed.

Minority representation on the support staff is much more encouraging. Of currently filled positions, 13 percent are from underrepresented minority groups.

Training
In order for library staff to keep up in the fast-paced, ever-changing world of technology, they must be proactive in seeking out and participating in skill development opportunities. The Libraries, in turn, must provide an environment that supports and encourages continuous learning.

Responsibility for providing technology training opportunities for library staff is shared by many groups and individuals in the Libraries outside of Administrative Services. For non-technology training, many library staff avail themselves of MIT's Office for Organization and Employee Development offerings, which are convenient and receive good reviews. Several specific opportunities were organized this year for library staff members.

- In an effort to develop strong presentation skills in our library professionals (for bibliographic instruction in the classrooms, demonstrations of library technologies and systems to the MIT community, presentations to Visiting Committee, donors, etc.) a workshop was scheduled last summer with a local trainer. Approximately 12 staff members learned how to present themselves and their material more effectively, through group exercises, videotaping, and critiquing.
- In response to a request from some newer supervisors, a special session of "Giving Performance Appraisals" was scheduled with MIT Human Resources. With the many competing priorities in the Libraries at that time, only four supervisors were able to attend. In preparation for the 2001 support staff performance evaluation cycle, another special session is planned.
- Complaint Handler's Training, led by Professor J. Samuel Keyser, was scheduled for 13 staff members in December 2001. It has been the Libraries' goal to provide this training to all supervisors as well as all committee members of the Libraries' Advisory Committee on Workplace Issues.

Participation in professional organizations and conferences is also an important way for librarian and other professional staff to receive training and keep up-to-date with current technologies and best practices in the library profession. The Libraries place a high value on professional development opportunities and provide financial support for travel, lodging, and registration fees. Despite the fact that this funding only represents partial funding of these important development activities, statistics show that the majority of the Libraries' professional staff participates regularly in some type of funded professional activity. Professional associations include the American Library Association, Library and Information Technology Association, American Society of Information Science, Geological Society of America, and the American Chemical Society.

PROCUREMENT

The procurement of library supplies and equipment and the monitoring of all contracts with vendors are completed by the Facilities and Operations Administrator. Due to the illness since February 2001 of the Facilities and Operations Administrator, members of the AS staff have shared many of the duties. The Staff Administrator assumed much of the day-to-day supervision of facilities, procurement, and parking.

CONCLUSION

This has been a year of great change for the staff of the Administrative Services Department. With significant personnel changes, the integration of other operations within the department, and a new department head, it has been a challenging time for all involved. However, it has been an opportunity for the AS staff to pull together and to learn more about each area within the department.

James Mullins

TECHNOLOGY PLANNING AND ADMINISTRATION

During this fiscal year the MIT Libraries has established itself as a committed player in the educational technology landscape of the Institute. The strong progress of our DSpace initiative, along with the creation of another Mellon-funded initiative, have helped draw vital attention and funding to the Libraries' role in educational technology. Libraries managers have participated in planning groups from MITCET to OCW, and expect to continue their engagement with educational technology efforts across the campus. And within the Libraries new ideas continue to be nurtured, building out our limited research experience. Even as we take a place at the campuswide ed-tech table, we also continue to improve our own operational technology foundations. This year we made the transition to the third generation of our Barton library management system, a transition which demanded extraordinary effort from our whole staff. We also revised our public web and our printing architecture with an eye on the sustainability of these services.

TAKING A SEAT AT THE EDUCATIONAL TECHNOLOGY TABLE

Libraries have long been at the heart of education technology on the campus. In fact, books are a masterful piece of educational technology, and all that libraries do to manage these assets for MIT are expressions of earlier efforts to master this educational technology. But the world moves on and today the new expressions of educational technology are in the digital realm, where again the library is building a role and reputation for itself.

MIT Libraries administrators now sit on both the MIT Council on Education Technology and the Open CourseWare steering committee. We have also engaged deeply in our role on the campuswide Information Technology Architecture Group. Managers of the Open Knowledge Initiative and Stellar projects from Academic Computing have sought our expertise, and Libraries staff have participated in the "knowledge summit" sponsored by these efforts. We have begun regular formal strategic planning meeting between the highest levels of Academic Computing and Libraries management, so that our efforts may be well coordinated. This participation in the Institute's vision and planning for educational technology has seen vital growth this year, and sprouts from the Libraries' mission and research agenda.

DSpace
The DSpace project, supported by the Hewlett-Packard Laboratories ($1.8M) and the Andew W. Mellon Foundation ($214,000) seeks to build a system which can capture, preserve, and communicate the research output of the Institute which is born in digital form (see http://web.mit.edu/dspace/). The project is now fully staffed and has defined the core attributes of the system. This year we established a Faculty Advisory Board which has met twice and a Technical Review Board which has helped the team confront some sticky technical choices. We have also identified a set of "early adopters" within the Institute. These departments, labs, and centers will begin to use DSpace in the fall of 2001, while the rest of campus will await the formal release of the repository in the first few months of calendar year 2002.

The MIT Libraries have also begun active planning for the handoff of DSpace from the research team to our operational technology group. This handoff could take place as soon as the summer of 2002.

We have also hired two Sloan MBAs to take on the Mellon-funded challenge of building a business model for DSpace. We believe such a plan to be crucial to our ability to sustain DSpace for the long term called for in our commitment to faculty.

EJournal Archiving
This year the MIT Libraries were gratified to attract a second Mellon Foundation grant ($140,000), this time for the purpose of planning for an ejournal archiving project. We are interested in tackling the archiving of a specific subset of the new scholarly literature, a medium we think will constitute the next generation of ejournal publishing, a medium we will call "dynamic ejournals." Dynamic ejournals are scholarly web sites which aim to share discoveries and insights, but do not feel bound by the conventions of "issues" and "articles" that have become standard in print. We believe that the dynamic ejournals currently published represent the leading edge of a broad range of dynamic content which we must learn to capture for future scholars.

This effort builds on the close relationship between the MIT Libraries and the MIT Press. The Press produces *CogNet*, one of the premier examples of a "dynamic ejournal" present in the world today.

The goal of this planning grant is to develop a proposal for actually undertaking the archiving task proposed for submission to the Mellon Foundation for further funding. This project proposal should be ready to submit to Mellon before the end of FY2002.

Digital Reference
One of the most encouraging aspects of our new energy around research into educational technology issues is the fact that staff throughout the Libraries now feel empowered to investigate new service ideas on their own initiative. One of the most intriguing initiatives from our staff this year has been one to develop a service which would place the skills of the reference librarian out on the net. Libraries have always been more than the sum of their collections, they have also offered skilled guidance and research assistance to those who stop at the desk in a reading room and seek such aid. Digital libraries have been missing this essential component of library service, and the digital reference team has been exploring ways to bring this service to the web.

This year the team succeeded in mounting a small pilot "Ask Us" service on the MIT Libraries web page. The team worked closely with LSSI, a library vendor who in turn works with a high-end provider of web-based interactive customer support and service systems. They have learned the benefits and limitations of such software while providing the library vendor with insight into the real needs of academic research libraries and their patrons. We hope to expand this pilot project in the next academic year.

TENDING TO OPERATIONAL TECHNOLOGY FOUNDATIONS
Even as we reach for new horizons and investigate our role in the emerging digital delivery mechanisms of education, we also have to tend to the established technologies of our trade. Managing the physical (and electronic) assets of the Libraries is done with the help of an automated system we call the "Library Management System." After six years of service, the current library management system reached the end of its anticipated functionality on schedule in FY2000. The process of migrating to a new system was begun last year and reached the implementation stage this year. We also found that our web site had outgrown its original design and functionality, and it was redesigned with the benefit of significant user input this year. And, finally, we found that to sustain the growth in printing inspired by networked resources, we had to move to a cost-recovery architecture for public printing.

Third Barton
This year's task was to make a choice between the Sirsi Unicorn system and the Ex Libris Aleph 500 system and then to implement that choice. Aiming for both selection and implementation in a single year was an ambitious agenda, but we felt the process would be difficult no matter the pace, and so were determined to press ahead as quickly as possible. We reviewed the vendor responses to an RFP issued last summer, solicited information from and made site visits to various sites currently running these two systems, compiled information from various phone and email contacts with the vendors, and most importantly, obtained extensive feedback from our staff following week-long hands-on demonstrations from each vendor. Our RFP was relatively brief, with much of the emphasis of

our process weighted toward the hands-on demonstrations provided to our staff. Our review led us to conclude that the Aleph 500 system from Ex Libris would be the best match for the MIT Libraries.

Contract negotiations took place in the fall of 2000. We promoted one of our staff to the position of Project Manager for the transition to the new system, and serious work on that transition began last December. The transition process has been difficult due both to the tight timeframe and to Ex Libris' decision to support our migration via a team operating in Israel. Our staff performed terrifically well planning for the transition, converting our data, and configuring the new system. We met our target of making the transition on the fiscal year boundary, missing our original forecast "switch-to-production" date by only one week. This target was met due to the extraordinary efforts of our staff over the past six months. We've documented that the effort required close to five percent of the total productivity of our staff during this period.

Public Web Redesign
When the MIT Libraries undertook its first professional design of its web pages four years ago, we developed a distinctive look which reflected our physical embodiment. Thanks in large part to usability studies by our Web Manager, we've learned that this reflection of our physical layout does not serve the MIT community very well. Our users, it turns out, would rather see a web page which emphasizes the services of the Libraries instead of their locations. And these services also need to be identified by names which are meaningful to the users themselves, rather than those which we in the libraries recognize. In retrospect, this all may seem self-evident, but diligent usability studies were the tool which unlocked our thinking and moved us toward a fresh solution.

These usability studies took place last summer and a redesign was embarked on this fall. The new design was unveiled to the community in June and has, to date, received warm reviews. Our Web Manager has worked with the campuswide web services team to pass along the techniques and strategy of usability studies and our web site redesign stands as tribute to their value.

Cost-Recovery Printing
The presence of meaningful quantities of relevant journal literature online has begun to change student and faculty collection utilization patterns. Photocopying journal articles has begun to give way to printing them from online collections. (Reading full articles online seems to await more advanced display technologies.) The MIT Libraries has noticed this shift as a decrease in photocopying and a corresponding increase in printing. While we charge for photocopies, which helps us recover the costs of the machines, service, and consumables involved, we were not charging for printing from computers. Given the shift underway, we realized we could not long continue to provide printing within the Libraries unless we found some way to recover the costs.

After some considerable investigation in 1999, we settled on a plan to add the same vend-a-cards to our public printing infrastructure as was already in place for photocopiers. Our cost analysis made it clear to us that even though we could expect a decline in online printing volume of as much as 75 percent once charging was in place, we would be able to recover the costs of the hardware, servers, and supplies required for public printing within three years.

We have been charging for public printing since February 2001 throughout the Libraries. Very few patrons need personal assistance to understand how the system works. We have begun to see the anticipated decline in online printing volume, but the experience of other libraries leads us to expect that volume will recover within four years. Perhaps most surprising of all, we have had only a very few complaints about the new charges.

NEW OPPORTUNITIES
The opportunities for applying technology to the work of the Libraries never end. In the coming year we hope to implement a laptop loan program which takes advantage of the wonderful new wireless networking made available to the Libraries though MITCET's initiative. We also expect to focus on issues of staff training that will enhance our ability to support the digital technology we present to both the public and our own staff. And we will have to seek new technology leadership since our Assistant Director for Technology Planning and Administration will halt his weekly commute from Minnesota. These and the continuing challenges of participating in the Institutes own educational technology dreams will keep the MIT Libraries innovating.

Eric Celeste

MIT PRESS
FY2001 was a busy, productive, turbulent year. Highlights include a record number of new titles released supporting continued growth in frontlist sales; successful completion of the monumental undertaking of building a new warehouse, moving 1.7 million books, and implementing a new inventory management/fulfillment system in partnership with Harvard and Yale; filling several critical positions in the Acquisition Department, including four new senior editors to replace defections; benchmark accomplishments in establishing data warehousing and electronic asset management systems; the launching of our first fee-based e-community, CogNet; the redesign and deployment of our web site; the first full year of the implementation of world pricing system; the completion of the process of mounting electronic files for all journals with our hosting partner CatchWord; equity adjustments for

about 35 percent of our staff; a record number of design and publishing awards and prizes; and the worst sales shortfall in Press history.

The financial year ending in June was the worst in recent memory for university press publishing in general. While budgeted shortfall in sales here was not as serious as for most of our sister presses (Yale, Chicago, California, Harvard), book division sales were $1.221 million under budget, the shortfall entirely attributed to domestic backlist sales. Journals net proceeds were about $250K less than expected. Nevertheless, we reported a breakeven on overall operations. No mean feat, especially in light of the warehouse/systems conversion completed during the year, and the other undertakings listed above.

On the positive side, UK/European sales were up 6 percent overall, exceeding forecast (In fact UK sterling sales were up 20 percent); subrights income was ahead of budget; and the MIT Press Bookstore sales exceeded forecast.

I think it would be useful here to recount the convergence of several events impacting industry-wide sales, some of which are elements of continuing trends and some particular to this past year.

At $350K, Canadian sales were down 50 percent from last year. The restructuring of major chains (Chapters and Indigo) forced us to put these customers on hold most of the year because they weren't paying their bills. A similar negative effect happened with Borders, a major chain and one of our major customers, whom we also put on hold for about nine months because we felt their accounting practices in terms of returns and chargebacks and lateness in bill paying left us no alternative but to cut them off until they cleaned up their act. They are buying books again in orderly fashion.

In general, financial stresses and strains that uniquely affect scholarly publishing continue, like the drain on library acquisitions budgets caused by the high cost of scientific, medical and technical journals published by commercial publishers, and the new costs of electronic communications technologies. Furthermore, the continuing growth of interlibrary loans of books, and more recently e-books, does not help sales.

In the textbook arena, students are downloading and printing books that university libraries have put on electronic reserve, free of charge. Campus copy shops are offering penny-a-page deals early in the semester, and turning their backs as students copy entire books. And the used textbook market is more sophisticated than ever. These days, if you go online and type in a title, you'll get seven or eight quotes for it, new and used.

But this last year, almost everybody got hammered from a new direction: the general retail market for books took a nosedive.

Beginning in the mid-1990's, university presses benefited from the explosion of superstores like Barnes & Noble and Borders, and web retailers like Amazon.com, all of which were large enough to make room for specialized, scholarly titles. Retailers and distributors greatly expanded their warehouse capacity to feed demand, creating a surge in orders to fill their shelves. Amazon.com, in particular, built four new warehouses in 1999 and added another last year. The Ingram Book Company, the other major distributor, also added new warehouse space and so did BarnesandNoble.com. During FY2001, growth in on-line book sales has flattened and Ingram closed two facilities, in Chino, CA and Denver, CO. In the past year, chains have consolidated, warehouses have closed, and Amazon has fallen on hard times. Finding they have ordered far more books than they can sell, those retailers are returning them to publishers by the crateload.

The Association of American Publishers' preliminary report on industry-wide book sales for 2000 showed sales of adult clothbound books down 11.6 percent and paperback sales down 7.2 percent. Sales of university press books also slumped overall, down 2.4 percent.

In recent years many independent bookstores, which are important channels for sale of scholarly books, have been forced to close by competitive pressure from chains, and that sad trend continues. The American Booksellers Association, the trade association for the independents, reported recently that its membership had dropped by almost 25 percent in the last year. The smaller chains are also starting to go under; Wallace's and Bibelot are both gone, and the largest chain in Canada, Chapters, is closing stores. Crown Books has filed for bankruptcy. Amazon closed one of its warehouses; Ingram, the largest jobber supplying trade bookstores, closed two of its distribution centers. All of these recent closings have exacerbated one of the chronic and intractable problems of the publishing industry: the practice by publishers of accepting unsold stock from bookstores and issuing credits against unpaid invoices. "Gone today, here tomorrow," is a bitter publishing joke in the best of times. The number of adult hardcover consumer books returned from bookstores in the first four months of this year rose 11 percent from last year, and the number of adult trade paperbacks rose 13 percent.

Table 2. Comparative Operating Results (In Thousands)

	FY2001	FY2000	FY1999
Total Net Book Sales	17,103	18,029	16,776
Cost of Sales	7,341	8,039	7,390
Gross Margin on Sales	9,762	9,990	9,386
Other Pub. Income	642	182	178
Bookstore Net	74	25	65
Total Income	10,478	10,197	9,629
Operating Expenses	10,549	9,996	9,436
Net Books Division	(71)	201	193
Journals Net	71	301	166
Net Pub. Operations	-	502	359

During FY2001 the university presses of MIT, Harvard, and Yale completed construction of a new distribution center, named TriLiteral, located in Cumberland, RI. MIT Press and Harvard University Press closed its existing joint warehouse, Uniserv, in Littleton, MA and moved all inventory to the new distribution center. MIT Press began shipping from the new facility in April 2001. In the spring of 2002 the three presses will merge their order processing and customer service operations into TriLiteral and will combine orders for their books into single shipments to the same customer accounts.

HIGHLIGHTS FROM THE BOOK DIVISION

MIT Authors:
Barrett et al., *The MIT Guide to Teaching Web Site Design*
Buchwald and Warwick, eds., *Histories of the Electron*
Byrne et al., eds., *Fact and Value*
Dornbusch, *Keys to Prosperity*
Kenstowicz, ed., *Ken Hale: A Life in Language*
Marantz et al., eds., *Image, Language, Brain*
Miller and Lessard, *The Strategic Management of Large Engineering Projects*
Pesetsky, *Phrasal Movement and Its Kin*
Sussman and Wisdom, *Structure and Interpretation of Classical Mechanics*
Williams, *Technology and the Dream*

Among the noteworthy books by non-MIT people from our scholarly and professional program were:
Auyang, *Mind in Everyday Life and Cognitive Science*
Brands, *Rethinking Public Key Infrastructures and Digital Certificates*
Branscomb and Auerswald, *Taking Technical Risks*
Brulle, *Agency, Democracy, and Nature*
Cabeza and Kingtone, eds., *Handbook of Functional Neuroimaging of Cognition*
Cargill et al., *Financial Policy and Central Banking in Japan*
Carroll, *Making Use*
Cope, *Virtual Music*
Darst, *Smokestack Diplomacy*
Davies, *Norms of Nature*
Davis and Steil, *Institutional Investors*
Faugeras and Luong, *The Geometry of Multiple Images*
Fields, *Distribution and Development*
Geiser, *Materials Matter*
Gollier, *The Economics of Risk and Time*
Gomory and Baumol, *Trade Conflict*
Guesnerie, *Assessing Rational Expectations*
Harel et al., *Dynamic Logic*
Heath, *Communicative Action and Rational Choice*
Jackson, *Spectrum of Belief*
Jacquemin, *Spotting and Discovering Terms through Natural Language Processing*
Jurist, *Beyond Hegel and Nietzsche*
Kecman, *Learning and Soft Computing*
Keijzer, *Representation and Behavior*
King, *Complex Demonstratives*
Levesque and Lakemeyer, *The Logic of Knowledge Bases*
Marcus, *The Algebraic Mind*
Mead, *Collective Electrodynamics*
Melamed, *Empirical Methods for Exploiting Parallel Texts*
Nelson and Luciana, eds., *Handbook of Developmental Cognitive Neuroscience*
Nolfi and Floreano, *Evolutionary Robotics*
Nordhaus and Boyer, *Warming the World*
Parker, *Physioeconomics*

Perry, *Knowledge, Possibility, and Consciousness*
Persson and Tabellini, *Political Economics*
Pillow, *Sublime Understanding*
Rattray, *Strategic Warfare in Cyberspace*
Redmond and Smith, *From Whirlwind to MITRE*
Ringius, *Radioactive Waste Disposal at Sea*
Rocke, Nationalizing Science
Rowe, *Machine Musicianship*
Salanié, *Microeconomics of Market Failures*
Smil, *Enriching the Earth*
Stern, *Metaphor in Context*
Sutton, *Marshall's Tendencies*
Thagard, *Coherence in Thought and Action*
Thomson, *A Guide for the Young Economist*
Townsend and Bever, *Sentence Comprehension*
Tye, *Consciousness, Color, and Content*
Walter, *Neurophilosophy of Free Will*

New hardcover books for trade and general audiences included:
Azoulay, *Death's Showcase*
Baldi, *The Shattered Self*
Batchen, *Each Wild Idea*
Bhagwati, *The Wind of the Hundred Days*
Brennan, *Painting Gender, Constructing Theory*
Connah, *How Architecture Got Its Hump*
Da Costa, *Global E-Commerce Strategies for Small Businesses*
Dowie, *American Foundations*
Easterly, *The Elusive Quest for Growth*
Fernandez-Galliano, *Fire and Memory*
Florman, *Myth and Metamorphosis*
Gottlieb, *Environmentalism Unbound*
Gould IV, *Labored Relations*
Grosz, *Architecture from the Outside*
Harries, *Infinity and Perspective*
Kachur, *Displaying the Marvelous*
Kwinter, *Architectures of Time*
Lavin, *Clean New World*
Leatherbarrow, *Uncommon Ground*
Lehmann, *Tigersprung: Fashion in Modernity*
Llinás, *I of the Vortex*
Manovich, *The Language of New Media*
Menzel and D'Aluisio, *Robo sapiens*
Murray, *Women Becoming Mathematicians*
Rajchman, *The Deleuze Connections*
Roberts, *The Invisible Heart: An Economic Romance*
Spinella, *The Psychopharmacology of Herbal Medicine*
Taylor, *Hans Bellmer: The Anatomy of Anxiety*

Books published primarily as texts included:
Allen and Hand, *Logic Primer*, 2nd ed.
Benninga, *Financial Modeling*, 2nd ed.
Cabral, *Introduction to Industrial Organization*
Cartwright, *Evolution and Human Behavior*
De La Grandville, *Bond Pricing and Portfolio Analysis*
Felleisen et al., *How to Design Programs*
Friedman et al., Essentials of Programming Languages, 2nd ed.
Gluck and Myers, *Gateway to Memory*
Ljungqvist and Sargent, *Recursive Macroeconomic Theory*
Mallot, *Computational Vision*
Murphy, *Introduction to AI Robotics*
O'Reilly and Munakata, *Computational Explorations in Cognitive Neuroscience*
Pevzner, *Computational Molecular Biology*
Roland, *Transition and Economics*
Snyder, *Music and Memory*
Viscusi et al., *Economics of Regulation and Antitrust*, 3rd ed.

Editors in the Acquisitions Department included: Laurence Cohen (Editor-in-chief; Social Theory, Science and Technology Studies); Roger Conover (Art and Architecture); John Covell and Elizabeth Murry (Economics, Finance, and Business); Clay Morgan (Environmental Studies); Barbara Murphy (Neuroscience); Robert Prior and Douglas Sery (Computer Science); and Tom Stone (Psychology and Linguistics).

JOURNALS

In FY2001, the Journals program had earned sales of $4.8 million, a four percent increase from last year. The deferred subscription reserve account increased from $1,946,544 to $2.3 million. The year was spent in improving processes for our new fulfillment system and in developing electronic versions of all our journals through a technology partner, CatchWord Ltd. In addition, the division was heavily involved in the launching of our electronic community MIT CogNet, and in supporting its marketing and subscription efforts.

Five new journals were added: *Journal of Machine Learning Research, Grey Room, American Journal of Bioethics, Global Environmental Politics,* and *NBER/Innovation Policy and the Economy* (annual). Five journals terminated or left our program mid-year: *Assemblage, Chicago Journal of Theoretical Computer Science, Harvard International Journal of Press/Politics, Journal of Functional and Logic Programming,* and *Real Estate Economics.*
The division ends the year still publishing 38 journals. The others are: *Artificial Life, Computational Linguistics, Computer Music Journal, Design Issues, TDR/The Drama Review, Evolutionary Computation, Harvard Design Magazine, International Organization, International Security, Journal of Architectural Education, Journal of Cognitive Neuroscience, Journal of Cold War Studies, Journal of Economics and Management Strategy, Journal of Industrial Ecology, Journal of Interdisciplinary History, Leonardo/Leonardo Electronic Almanac/Leonardo Music Journal, Linguistic Inquiry, NBER Frontiers in Health Policy Research, NBER Macroeconomics Annual, Markup Languages, NBER Tax Policy and the Economy, Neural Computation, Neurology and Clinical Neurophysiology, October, Perspectives on Science, Presence: Teleoperators and Virtual Environments, Reflections: The SoL Journal, Review of Economics and Statistics, Quarterly Journal of Economics, Studies in Nonlinear Dynamics and Econometrics,* and *The Washington Quarterly.*

EDITORIAL AND MANAGEMENT BOARDS

Faculty serving on the MIT Press Editorial Board this year were Joshua Cohen, Carol Fleishauer, Rafael A. Bras, Jed Buchwald, Joseph Jacobson, Leslie Pack Kaebling, Nancy Kanwisher, Michael Scott Morton, and Board Chair William Mitchell. Frank Urbanowski and Ann Wolpert served as ex-officio members.

The MIT Press Management Board met twice during the year. Members of the Board were: Ann J. Wolpert (board chair), Mary Curtis, Joseph Esposito, Jack Goellner, William Arms, John Hanley, Stephen Lerman, William Mitchell, Richard Rowe, Jerome Rubin, Richard Schmalensee, Hal Abelson, and Ian Page. Frank Urbanowski served as ex-officio.

DIGITAL PROJECTS LAB (DPL)

The Press's flagship e-community site for the brain and cognitive sciences, CogNet, launched as a fee-based service on October 1st of last year. Through the end of June 2001 we have acquired 47 paid institutional site licenses totaling $62k and an additional $15k in member subscriptions by individuals. This coming fiscal year we plan to upgrade our software toolkit (from the ArsDigita Community System to a Java-based architecture).

The DPL is also involved in a major initiative to digitize the Press's out-of-print book and journal collection. Approximately ~2500 books from the Press's complete published collection of ~6500 titles are now out of print and unavailable. The project is a joint venture with Hewlett Packard Laboratories' Digital Content and Remastering Department. The DPL is currently staffed by a general manager, a senior project manager, one lead programmer/analyst and two junior programmers, and a web designer.

MARKETING

The Marketing Department at The MIT Press took on two major projects in the last fiscal year. We built a new web site, in cooperation with the journals department, and we played a major role in the move to the new warehouse and in the implementation of a new order processing system, which also includes a sales analysis and accounting module.

Overall sales were down from last year by 5.1 percent, due mainly to two factors, one foreign and one domestic. A major bookselling chain in Canada, Chapters, went bankrupt. In previous years, we had done over $300,000 in business with this chain. In the U.S., a major wholesaler closed two distribution centers which cut our sales to wholesalers by roughly $900,000 overall. Despite these two major losses, which add up to over $1,200,000, gains were made in other sectors leaving us down in net dollars by $925,100.

Because Chapters is merging with a viable chain and the merger has been approved by the Canadian government, and because we see signs of stabilization in the wholesaler sector in the U.S., we have projected a modest increase in income for next year. Reports from Domestic Sales, Promotions, International Marketing and Electronic Marketing follow.

Domestic Sales
After the last three years of strong sales led by triple digit growth in our webseller market, sales for FY2001 experienced an abrupt flattening. While front list sales remained strong, back list sales dropped significantly due to the distribution downsizing of a few of our largest customers. In the past year, warehouses for Ingram, amazon.com, and fatbrain.com have closed a total of seven warehouses. In addition to these closures some significant accounts have gone out of business, including Crown, Bibelot, and BigWords.com. Last year we estimated that 50 percent of the MIT Press books sold online were provided through a wholesaler. It is no surprise that this is the hardest hit customer category this fiscal year, down from $5,466,687 to $4,544,589. Wholesalers not only absorb the .com downturn but also the returns of small chains and independents that have gone out of business.

In addition to closing warehouses, most accounts large and small, are adopting a philosophy of "just in time" ordering. For instance, Ingram, who in the past ordered for a 12–16 week ordering cycle has now trimmed this to 6–8 weeks. Most realize overstocking is expensive and are instead increasingly relying on publishers for quicker order turnaround. The importance of recently updating our warehouse operations cannot be overstated. Speed of delivery will become a key component in maintaining favorable status with our accounts and allowing us to more time to effectively capitalize on various forms of publicity that often hit with little lead time to get books to accounts.

Chain stores remain strong with Barnes and Noble adding FatBrain to their company roster. Barnes and Noble's distribution centers now provide fulfillment for their superstores, their college division, bn.com, and FatBrain.com. After their deal fell through last year with Ingram, Barnes and Noble have put considerable emphasis on distribution self-sufficiency, providing another blow to wholesalers who were heavily relied upon by the chains to fulfill special orders and high level stock. In August, we resumed shipping to Borders after placing them on hold for nine months while we worked out various issues concerning late payments, excessive returns, and chargebacks.

Electronic Marketing
With the help of an outside web developer and designer, the Press has developed an all new web site. Slated to launch in July, the new site brings many new features and upgrades, including an updated graphic design, a modern shopping cart system, and vastly improved searching capabilities. One of the site's most important features is an improved categorization system, allowing for better linking between related books, journals, and digital products. The new site's open architecture will allow the Press to undertake several system integration projects in the coming year. The site will be linked with our Bookmaster fulfillment system, making possible much quicker order turnaround, and also with the EclipseNet journals fulfillment system, which will allow journals customers to access their subscription information online. The site may also be upgraded to handle real-time e-commerce transactions for e-book order fulfillment.

International Marketing
MIT Press total export sales during FY2001 came in at $5.047M—down 5.5 percent from previous fiscal year. Total export sales account for approximately 30 percent of overall book sales for the Press.

Our best results for international sales came out of our London Office/Wiley UK—combined UK and European sales increased to $3.280M up 2.8 percent over previous fiscal year. It's been a mixed selling season in the UK seeing sales growth and optimism with the independents, wholesalers, museum and gallery shops, and specialist booksellers—while it was another difficult period for UK chain booksellers such as Waterstone's and Blackwells due to heavy returns and continuing management problems. Sales in continental Europe are holding steady despite the majority of independent bookseller's ongoing concern over the high list prices of most imported English-language books. Our European sales are coming almost entirely from the academic independent booksellers.

In the Canadian market, we suffered enormous returns from Chapters, Canada's largest chain bookseller which was sold last year and recently merged with Canada's other leading chain Indigo Books, and has now become Chapters-Indigo. Chapters remained on credit hold for most of FY 01 due to not having made a payment to MITP since August 2000. Payment delays and returns of up to 100 percent by Chapters, were problems felt industry-wide by Canadian and US publishers. The sales that we did acheive in Canada were from the independents and mostly text sales.

The weakened Australian dollar continues to make imported US books expensive and consequently Oz consumers cut back on purchasing books including much needed academic and reference titles. Text sales remain steady due to special pricing considerations to make the books more affordable.

Sales to Japan are slightly down from last fiscal year and perhaps not too worisome at this time – the slight decline due to expected cuts in both private and public university library budgets. In other export markets we experienced sales growth in parts of the Far East, Middle East and sub-Continent but sales to Latin America remain exceedingly challenging except for the significant iincrease in sales to Mexico. All export sales felt the impact of the move to the new warehouse –TriLiteral, by way of delayed order processing and shipments.

Table 3. Export Sales

	FY 2001 Actual	FY 2000	Actual + / -
Australia	$144K	$173K	-17%
Canada	$315K	$597K	-47%
Japan	$605K	$626K	-3.5%
UK/Europe	$3.280M	$3.190M	+2.8%
All Other Export	$702K	$741K	-5.5%
Total Export	$5.046M	$5.328M	-5.5%

Direct Mail
Fiscal Year 2001 was an extremely active direct mail year, with the production of fourteen subject area catalogs, two special promotions, numerous single book flyers, and two seasonal announcement catalogs. Because of our conversion to Bookmaster, we are currently unable to produce sales reports that fully reflect our direct mail sales for the fourth quarter. We estimate our traceable direct mail sales for FY2001 to be about $179,170. Direct mail's bottom line continues to be down from previous fiscal years. We believe direct mail sales are hurt primarily by online booksellers, who can offer much quicker delivery than we can, as well as discounts on some titles. Nevertheless, we continue to believe that direct mail remains a highly effective means of promoting MIT Press titles, and of making our professional customers aware of new and backlist books in their specific areas of interest.

Our Cognitive Science catalogs reflected the strongest direct mail sales at $34,432 for the year. This is followed by Economics at $30,659, and Neuroscience at $23,646.

Textbook Sales
FY2001 we mailed thirty direct mail text promotions to over 85,000 U.S. professors in various disciplines. The fall of 2000 saw the largest direct mail promotion in at least a decade. Highlights included new editions of the best selling texts of Benninga's *Financialing Modeling* and Viscusi's *Economics of Regulation and Antitrust.* New editions of successful texts are important revenue generators for The Press. At one point, both the first and second editions of Benninga's text were on our bestseller list. Fall 2000 also featured two major new economics texts in Cabral's *Introduction to Industrial Organization* and Ljungqvist and Sargent's *Recursive Macroecomnimc Theory.* Because the warehouse change occurred at the same time that spring direct mail text requests were arriving, we fulfilled text requests from the office. This involved sending out hundreds and hundreds of examination copies. Highlights of the Spring campaigns were Friedman/*Essentials of Programming Languages 2E,* which we took over from Mcgraw Hill, and Felliesen/*Introduction to Computer Programming.* Felleisen has recently been adopted at Georgia Tech for a class of 1500 students per semester, one of the largest adoptions ever for one of our textbooks.

Exhibits
The MIT Press exhibited titles at 168 U.S. professional and academic conferences in FY2001, generating $143,784 in onsite sales plus $222, 735 in "mail-in" sales. Total sales generated by U.S. exhibits in FY2001 was $366,519, an increase of more than $59,000 from FY2000. Overall expenses this year were slightly lower than last year's.

The year's top ten U.S. conferences, ranked by sales are:
1. Society for Neuroscience, November 5–8, 2000, New Orleans, LA
2. Allied Social Science Association, January 5–7, 2001, New Orleans, LA
3. College Art Association, February 28–March 3, 2001, Chicago, IL
4. Econometric Society World Congress, August 11–16, 2000, Seattle, WA
5. International Society of Molecular Biology, August 20–23, 2000, La Jolla, CA
6. Society for Research in Child Development, April 19–22, 2001, Minneapolis, MN
7. Association for Research in Vision and Opthalmology, April 29–May 4, 2001, Fort Lauderdale, FL
8. Super Computing 2000, November 16–19, 2000, Dallas, TX
9. American Association for Artificial Intelligence, August 1–3, 2000, Austin, TX
10. Psychonomic Society, November 16–19, 2000, New Orleans, LA

Advertising
Advertisements for MIT Press books appeared in almost 600 trade and scholarly journals and magazines, as well as conference programs and web sites. All of these ads were produced in-house by our Advertising Manager. The continued focus of the advertising program is to implement better target marketing and wider exposure, with an eye to new print and online media, while staying under budget. Major ad campaigns were implemented for *Robo sapiens, MIT CogNet, Labored Relations, Culture in Practice, Recursive Macroeconomic Theory, Gateway to Memory, The Wind of the Hundred Days, Clean New World, Karl Blossfeldt, The Elusive Quest for Growth, Writing on Water, and The Invisible Heart.*

Advertisements for these books appeared in such publications as *American Scientist, Technology Review, The New York Review of Books, Economic Journal, Foreign Affairs, Chronicle of Higher Education, The Nation, New Republic, Lingua Franca, Mother Jones, Whole Earth, The New York Times Book Review, Art in America,* and *Artforum.* Banner ads were placed on the slash.org web site.

Publicity
MIT Press titles received extensive coverage in U.S. newspapers, magazines and journals in FY2001, and a number of MIT Press authors discussed their work on radio and television programs.

This year's most widely and favorably reviewed title was *Robo sapiens: Evolution of a New Species* by Peter Menzel and Faith D'Aluisio. An illustrated look at the current state of robotics, the book presents haunting photographs of humanoid and biomimetic robots along with interviews and profiles of their inventors, most of whom work in labs in the U.S., Europe, and Japan. *Robo sapiens* was the subject of feature articles and reviews in *Wired* magazine (cover story, September 2000), *Discover* magazine, *Scientific American* (featured review), *The Wall Street Journal, Salon.com, The San Jose Mercury News, The San Francisco Chronicle, The Industry Standard, Business 2.0, Psychology Today, ArtByte, Publishers Weekly*, and many others. In his *Scientific American* review, professor and science fiction writer Vernor Vinge say, "It is very difficult to write clearly and simply about such things and still remain faithful to the underlying technology. Menzel and D'Aluisio accomplish this feat. The interviews and sidebars are consistently intriguing but also show great effort in avoiding the misinterpretations that could come from comparing so many different research enterprises . . . Menzel's color photos are beautiful and, for the most part, extremely effective."

Russell Roberts's *The Invisible Heart: An Economic Romance* also received high-profile coverage. Milton Friedman called the book, which uses the genre of romance fiction to address current economic and business issues, "A page-turning, well-written love story that also teaches an impressive amount of economics." The author discussed the book on television and radio programs including C-SPAN's Book-TV, NPR's *"Talk of the Nation,"* and CNBC's *"Today's Business."* Reviews and opinion pieces about the book appeared in *Barron's, The Financial Times, The Wall Street Journal, Washington Post, American Enterprise Magazine* (excerpt), *National Journal, Reason Magazine, The Chronicle of Higher Education, Business Economics, The Daily Telegraph, Publishers Weekly, Kirkus, St. Louis Dispatch, The Irish Times* and others. George Will's widely-syndicated *Washington Post* column called *The Invisble Heart* "delightfully didactic." A starred review in *Kirkus* described it as "radical economic ideas delivered as marvelously inventive fiction." *Publishers Weekly*'s review called the book a "snappy, well-written novel [that] casts economic polemic in fictional form."

Jagdish Bhagwati's *The Wind of the Hundred Days: How Washington Mismanaged Globalization* also received a substantial amount of U.S. coverage. Reviews, news stories, interviews, and opinion pieces appeared in *Booklist, Foreign Affairs, Lingua Franca, International Economy Magazine, Business 2.0, The New York Times, Industry Standard* (web site), *International Finance, Barnes & Noble, The Chronicle of Higher Education, The Independent,* and *the India-West newspaper.*

Maud Lavin's *Clean New World* has so far been reviewed by *The New York Times Book Review, Chicago Tribune, Chicago Magazine, Design Issues, Metropolis, Artbyte, I.D., Print Magazine, Techdirections,* and *Afterimage.* Rodolfo Llinas's *I of the Vortex* was reviewed *by Discover magazine, American Scientist,* and *the San Francisco Examiner,* and excerpted in *Cerebrum.*

Vaclav Smil's *Feeding the World: A Challenge for the Twenty-First Century* received positive reviews in all three of the major U.S. general science publications. *Science, The American Scientist,* and *Scientific American* all praised Smil's book, which explains how we can produce enough food to support the world's growing population, without irreparably damaging the biosphere. (On the strength of this book and others, Smil is the recipient of this year's AAAS prize for Public Understanding of Science and Technology, as described in the awards section, below.)

Electronic Promotion
In FY2001, we posted announcements of all new professional and many new trade books to email lists and Usenet groups in relevant fields. We also negotiated links from related web sites to our own. And we made extensive use of our own email lists, which contain the email addresses of visitors to our site who have bought books, subscribed to journals, or asked to receive announcements of new titles on particular subjects. Over the past year, we have developed robust databases that generate book announcements more quickly, store detailed information more effectively, and report more clearly on electronic promotion activities.

This type of promotion works particularly well for certain kinds of books, and we spent additional time promoting these books, using listserv search engines and exploring the Internet to find appropriate lists and web sites. Titles in computer science, robotics, and new media, which often garner hundreds of hits per month as a result of our e-promotion campaigns, represent a large portion of the books in this category. *Making Use* by John Carroll, for example, received 221 hits in a one-month period, while *Introduction to AI Robotics* by Robin R. Murphy received 231.

Certain books in other categories also garnered many hits, often from people who receive announcements through our email lists. *The Mind Doesn't Work that Way* by Jerry Fodor received 185 hits after we sent an announcement to our Philosophy email list, our Cognition, Brain, and Behavior email list, and two listservs. *Women Becoming Mathematicians* by Margaret A. M. Murray, which received 70 hits in one month, appeared on a number of women's-studies-related listservs and web sites in addition to our History of Science and Technology, Science and Technology, and Gender Studies email lists.

Awards

The Press's books and authors were honored in a wide variety of contexts and competitions in FY2001, with particular recognition in the categories of design and lifetime achievement. Titles winning multiple design awards include *Each Wild Idea: Writing, Photography, History* by Geoffrey Batchen, which won four awards for its elegant design by (former) MIT Press designer Ori Kometani, and *Tigersprung: Fashion in Modernity* by Ulrich Lehmann, which won three awards for its design, also by Ori Kometani. *Hands on the Land: A History of the Vermont Landscape* by Jan Albers, *The Architecture of Red Vienna, 1919–1934* by Eve Blau, and *Women Becoming Mathematicians: Creating a Professional Identity in Post-World War II America* by Margaret A. M. Murray each won two design awards.

Two MIT Press authors were presented with Lifetime Achievement Awards in 2001. Vaclav Smil, author of numerous MIT Press titles including *Energies, Enriching the Earth*, and *Feeding the World*, received the American Association for the Advancement of Science (AAAS) Award for Public Understanding of Science and Technology presented in February of 2001 at the association's annual meeting in San Francisco. This prestigious award "honors working scientists and engineers who make outstanding contributions to the 'popularization' of science." Lewis Branscomb, who has edited several MIT Press titles on science and technology policy, received the Vannevar Bush Award presented in May of 2001 by the National Science Board (NSB) at a Department of State-hosted awards dinner. The award is given for lifetime achievement in science and public service.

Here are some additional highlights from July 2000 through June 2001. For outstanding design, MIT Press books were honored in five different competitions.

Tigersprung: Fashion in Modernity by Ulrich Lehmann, in the categories of Scholarly Illustrated and Jackets and Covers, and *Each Wild Idea: Writing, Photography, History* by Geoffrey Batchen, in the category of Scholarly Illustrated, were chosen as winners in the AAUP annual Book, Jacket, and Journal competition for excellence in design. The competition took place on January 11 and 12, 2001. The winners were showcased at the Association of American University Presses (AAUP) Annual Meeting in Toronto, June 16–19, and then proceeded on a tour.

Photography in Boston, 1955–1985 edited by Rachel Rosenfield Lafo and Gillian Nagler, along with book designer Jean Wilcox was awarded First Place in the category of Books Over $10 in the New England Museum Association Publications Award presented by the New England Museum Association (NEMA). The book will be exhibited at the NEMA annual conference in Newport, Rhode Island, November 14–16, 2001 and the winners will be announced in the summer issue of *NemaNews.* Following the conference, all entries are donated to the Boston Public Library.

Each Wild Idea: Writing, Photography, History by Geoffrey Batchen and *Tigersprung: Fashion in Modernity* by Ulrich Lehmann were chosen as "outstanding examples of book and book cover design" in the AIGA 50 Books/50 Covers of 2000 competition presented by the American Institute of Graphic Arts (AIGA). The books will be displayed at AIGA's National Design Center in New York, August 2001. The show will travel nationally and be documented in *365: AIGA Year in Design*, AIGA's annual design compendium. The winners will also exhibit at the Frankfurt International Book Fair, fall 2001.

Each Wild Idea: Writing, Photography, History by Geoffrey Batchen, *Tigersprung: Fashion in Modernity* by Ulrich Lehmann, and *Women Becoming Mathematicians: Creating a Professional Identity in Post-World War II America* by Margaret A. M. Murray were selected to appear in *Print: America's Graphic Design Magazine* as part of *Print's* Regional Design Annual 2001. The books will appear in the section devoted to the Eastern Region of the country in late September, 2001. The designers will receive Certificates of Design Excellence in recognition of their outstanding work.

Each Wild Idea: Writing, Photography, History by Geoffrey Batchen was awarded a BoNE (Best of New England) Award presented by the American Institute of Graphic Arts (AIGA) Boston. This book was chosen from among 117 books as one of 39 of the best designed books featured at the 2001 BoNE Show on display at MassArt's Bakalar Gallery June 7–July 13, 2001. The 117 books in the show were selected from 800 entries. The following MIT Press books also appeared in the show: *The Internet Upheaval: Raising Questions, Seeking Answers in Communications Policy* edited by Ingo Vogelsang and Benjamin M. Compaine, *Clean New World: Culture, Politics, and Graphic Design* by Maud Lavin, *Truth from Trash: How Learning Makes Sense* by Chris Thornton, *Coherence in Thought and Action* by Paul Thagard, and *Noise, Water, Meat: A History of Sound in the Arts* by Douglas Kahn.

In addition to winning a design award, *Women Becoming Mathematicians: Creating a Professional Identity in Post-World War II America* by Margaret A. M. Murray received Honorable Mention in the category of History of Science and Technology in the 2000 Professional/Scholarly Publishing Division Annual Awards Competition presented by the Association of American Publishers, Inc. Winners in this competition included *An Odd Kind of Fame: Stories of Phineas Gage* by Malcolm Macmillan in the category of History of Science and Technology and *How Children Learn the Meanings of Words* by Paul Bloom in the category of Psychology. The awards were presented at a luncheon ceremony on Tuesday, February 6, 2001 during the P/SP Annual Conference in Washington D.C.

Another double winner, *Hands on the Land: A History of the Vermont Landscape* by Jan Albers was awarded the 2001 Media Award presented by the National Arbor Day Foundation and one of the Vermont Book Professionals

Association (VBPA) Milestone Awards 2000 as one of the Judges' Three Favorite Books, chosen from the Twelve Best Books of Vermont. The Media award recognizes outstanding publications which bring issues relative to the importance of trees and conservation to the public and was presented on April 28, 2001 at the 29th annual National Arbor Day Awards Banquet and Ceremonies in Nebraska City, Nebraska. The VBPA Awards were presented at the VBPA Awards Night held at the Montshire Museum in Norwich, VT June 9, 2001.

The Architecture of Red Vienna, 1919–1934 by Eve Blau received two awards, recognizing this book's importance as a representation of both Austrian culture and architecture. The Center for Austrian Studies presented this title with the 2000 Austrian Cultural Institute Prize for the best book on Austrian History announced at the center's annual conference on April 5, 2001. The Society of Architectural Historians rewarded Blau's book with the 2001 Hitchcock Award for excellence in architectural publications. This award was presented at the society's Annual Meeting on Thursday, April 19, 2001 in Toronto, Ontario.

Another book honored at the Society of Architectural Historian's Annual Meeting was *Mapping Boston* by Alex Krieger and David Cobb with Amy Turner. This book received the 2001 Philip C. Johnson Award. As with the Hitchcock Award, this prize is given for excellence in architectural publications.

Two medical awards have been given to MIT Press books. The First Prize for the American Medical Writers Association (AMWA) Medical Book Award in the category of Books for Allied Health Professionals was awarded to *Confessions of a Medicine Man: An Essay in Popular Philosophy* by Alfred I. Tauber. The William H. Welch Medal for 2001 presented by the American Association for the History of Medicine was awarded to *The Expressiveness of the Body and the Divergence of Greek and Chinese Medicine* by Shigehisa Kuriyama. The medal is awarded "to the sole author of a book of outstanding scholarly merit in the field of medical history published during the five calendar years preceding the award."

The International Studies Association presented the Press with two awards. The Harold and Margaret Sprout Award for the best book published on the topic of international environmental affairs was presented to *Exporting Environmentalism: U.S. Multinational Chemical Corporations in Brazil and Mexico* by Ronie Garcia-Johnson by the Environmental Studies Section of the ISA. *Domestic Sources of International Environmental Policy: Industry, Environmentalists, and U.S. Power* by Elizabeth R. DeSombre received the 2001 Chadwick F. Alger Prize for the best book published in 2000 in the area of international organization. The awards were presented on Thursday, February 22, 2001 at the ISA convention in Chicago.

In economics, The MIT Press received the 43rd Nikkei Prize for Excellent Books in Economic Science for *The Spatial Economy* by Masahisa Fujita, Paul R. Krugman, and Anthony J. Venables. The award was announced on October 11, 2000 by the Japan Center for Economic Research (JCER).

In photography, *Germaine Krull: Photographer of Modernity* by Kim Sichel was chosen as a finalist in the 2000 Kraszna-Krausz Photography Book Awards presented by the Kraszna-Krausz Foundation. The winners were announced at The Arts Club in London on Tuesday, February 6, 2001.

The 2001 Lionel Trilling Book Award for the best book by a Columbia University professor was awarded to Jonathan Crary for *Suspensions of Perception: Attention, Spectacle, and Modern Culture*. The awards were presented at Columbia's annual awards ceremony, Monday, April 23, 2001 by the 2001 Academic Awards Committee of Columbia College.

Robo sapiens: Evolution of a New Species by Peter Menzel and Faith D'Aluisio was a winner in the Independent Publisher Book Awards (The IPPY Awards) in the category of Science presented by *Independent Publisher* Magazine. The awards were presented at Book Expo America (BEA) in Chicago, IL June 1–3, 2001.

Finally, the Lewis Mumford Award for Outstanding Scholarship in the Ecology of Technics presented by the Media Ecology Association (MEA) was presented to *Remediation: Understanding New Media* by Jay David Bolter and Richard Grusin. The award was announced at the MEA's annual convention in New York City, June 15, 2001.

SUBSIDIARY RIGHTS

Our subsidiary rights program has at its core the sale of translation rights to our books. The income generated by the licensing of foreign rights decreased by seven percent since FY2000. The number of translation contracts increased from 108 contracts signed during FY2000 to 124 during the same period in FY2001. The average size of the advances paid against royalties has decreased slightly in most markets, particularly Japan, due to a struggling economy. However, royalty scales remain stable and over time we make up for smaller advances with royalties. The number of translation contracts signed for simplified character editions for distribution in mainland China continues to increase steadily, as do the advances and the royalty scales. Total income from translations remains spread evenly between backlist and frontlist titles. Our strongest disciplines in the translation market are economics and cognitive science.

A significant shift over the last few years has been the increase in income from our reprint program, which includes permission to photocopy and to publish excerpts from our books, as well as the sale of paperback reprints. It is

unfortunate that in FY2001 *The Sciences*, one of our best clients for excerpts, was closed down by the New York Academy of Sciences.

In the category of reprint sales, we continue to license selected English language reprints in those markets where we forecast limited income from sales of our own editions. Income from our reprint program increased by eighteen percent since FY2000, and constitutes a substantial portion of total subsidiary rights income.

During FY2001 income from sales to book clubs increased by 78 percent since FY2000. Following a period of consolidation and reorganization in the book club industry, the number of MIT Press titles featured continues to increase gradually. This market is the least predictable for subsidiary rights; it depends both on our publishing list and on the financial formula required by book clubs.

Income from the license of electronic rights during FY2001 increased by 19 percent. This figure is somewhat misleading—we make a distinction between sales of the entire book in electronic form and sales of portions of books for which we receive royalties on the basis of frequency of access. Only the second category is included as subsidiary rights income. Overall, subsidiary rights income in FY2001 increased by 6.1 percent over FY2000.

Table 4. Subsidiary Rights Income

	FY1999	FY2000	FY2001
Translations	$149.078	$198,668	$184,081
Reprints	$193,356	$206,484	$243,988
Book Clubs	$2,683	$4,098	$7,298
Electronic, AV rights	$4,559	$3,574	$3,996
TOTAL:	$349,476	$412,034*	$439,363

*Please note that this total reflects disbursement of royalties due an author who requested payment before the end of the royalty year.

Bookstore Sales

Table 5. FY2001 dollar sales compared to FY2000

Month	Total (w/o tax)		HC	PB	JOURN	HURT	MISC.	Non-MITP
July	54,904	-2.2%	14,239	8,334	318	3,627	2,533	25,853
August	58,896	-8.2%	13,305	9,879	310	4,217	2,370	28,815
September	104,468	57.6%	23,890	13,719	303	31,792	3,651	31,113
October	65,362	-20.4%	16,351	10,408	262	2,784	1,841	33,716
November	61,335	-2.1%	17,226	8,858	377	2,569	1,554	30,751
December	62,084	-5.8%	15,765	8,954	465	2,103	2,752	32,045
January	50,902	3%	12,758	9,095	468	1,639	1,167	25,775
February	65,511	3%	19,824	12,894	349	2,369	1,592	28,483
March	56,314	-10%	15,742	9,534	680	3,245	1,670	25,443
April	93,305	55%	19,381	10,510	570	30,291	1,957	30,596
May	60,605	-1%	16,341	11,021	453	4,563	1,966	26,261
June	59,896	2%	14,037	8,963	493	3,498	1,877	31,028
TOTAL FY2001	793,582		198,859	122,169	5,048	92,697	24,930	349,879
% comparison 00		6%	-10%	6%	-14%	143%	-11%	2%
% comparison 99		5%	-9%	-6%	-17%	71%	5%	9%
% of sales			25%	15%	1%	12%	3%	44%
MITP portion	418,773 = 53% of sales							

Sales in FY2001 climbed six percent compared to the previous year to give us the third highest grossing total in our store's history. Growth areas included a six percent rebound in MIT Press paperback sales, a two percent rise in non-MIT Press items, and a 143 percent rise in hurt book sales. The large increase in hurt book sales was largely due to the two "loading dock sales" we held this year which themselves grossed about $55K. We also had success in correcting the slide in Press vs. non-Press sales with 53 percent of sales this year being made on MIT Press books (as opposed to 50 percent last year). Press hardcover sales dropped for the second year in a row; we will increase our efforts to rectify this trend.

One of our goals for this last year was to reduce the amount of stock in the store while maintaining depth and sales. Through more intelligent ordering and more efficient stock handling, we successfully reduced the amount on non-MIT Press inventory by 18 percent and the amount of MIT Press inventory by six percent.

Our second major goal was to reduce the Bookstore's expenses without hurting sales. We successfully cut our expenses in all areas. Our overall expenses were 17 percent less in FY2001 than compared to FY2000.

We benefited this year from a relatively stable staff of talented booksellers and look forward to a period of more focused training in the new fiscal year. Also, the newly instituted dual-management system continues to work effectively and efficiently.

In addition to previously mentioned successes in inventory control and operating expenses, we continued our plan of physical improvements in the store with the installation of a new anti-theft security system, an improved computer infrastructure, and a more efficient redesign of our office and storage areas.

In the new year we intend to continue improvements to the store interior, including a new lighting system, new in-store signage, and better display units. We also plan to increase the street visibility of the store. Further work on the bookstore website is also on the agenda.

Frank Urbanowski

LINCOLN LABORATORY

Lincoln Laboratory is a mission-oriented laboratory operated by MIT for the Department of Defense (DoD) carrying out research and development in surveillance, identification, and communications. The laboratory is celebrating its establishment by MIT fifty years ago in 1951 as Project Lincoln in response to a request from the Army, Navy, and Air Force. During the past year, agencies of the DoD—namely, the Air Force, the Army, the Navy, the Defense Advanced Research Projects Agency (DARPA), the Ballistic Missile Defense Office (BMDO), and the National Reconnaissance Office (NRO)—supplied approximately 88 percent of the laboratory's budgetary support. The Federal Aviation Administration (FAA) provided most of the non-DoD support, which additionally includes work for the National Aeronautics and Space Administration (NASA) and the National Oceanographic and Atmospheric Agency (NOAA). Lincoln Laboratory also carries out pre-competitive research with industry under approved Cooperative Research and Development Agreements. For the federal fiscal year 2000, Lincoln Laboratory received $361.5 million, supporting the efforts of 1200 professional technical staff.

ADMINISTRATIVE

The following administrative changes occurred at the laboratory Steering Committee level. Dr. Antonio F. Pensa, Head of the Aerospace Division, was promoted to Assistant Director. Mr. Carl E. Nielsen, Jr., Assistant Director, has retired following over 39 years of service to the laboratory. Mr. William M. Brown, Jr., was promoted to Head and Dr. Grant H. Stokes was promoted to Associate Head of the Aerospace Division. Mr. Kenneth F. Colucci joined the laboratory in the position of Assistant to the Director for Strategic Resources.

PROGRAM HIGHLIGHTS

Activity at the laboratory focuses on DoD tasks in surveillance, information extraction, and communications technologies, supported by advanced electronic technology and on air traffic control technology for the FAA. Technical work areas include radar and optical sensors, measurements, and systems; communications; signal design and processing; identification algorithms; lasers; solid state devices; digital technology, circuitry, and data systems; and tactical control systems. Unclassified summaries of several accomplishments during the past year are presented below.

SURVEILLANCE TECHNOLOGY

Health Surveillance and Biodefense Study

The Defense Threat Reduction Agency selected Lincoln Laboratory to lead a study on a proposed means of dealing with a bioterrorist attack on the U.S. homeland. This national study includes participants from MIT, Harvard, other universities, and the government, and follows a Defense Science Board (DSB) summer study on bioterrorism. The context of the DSB's defensive strategy is to monitor sick patients presenting to physicians and hospitals by utilizing emerging technologies of genetic and proteomic diagnostic chips. Output from the diagnostics would be compared with pathogen databases and reported via a national network. The immediate study will be to build upon the DSB recommendations, and provide an R&D investment strategy in this area for the Department of Defense.

Fluorescence Detection Of Biological Agents

The Bio-Aerosol Warning Sensor (BAWS), a UV-fluorescence-based detector of aerosols of biological origin, has been developed at Lincoln Laboratory to provide warning of a potential biological threat. The BAWS sensor is the result of a four-year development effort, and exploits the laboratory's previously developed microchip laser as a high-power, compact source of short pulses for exciting the fluorescent signatures of biological particles. The successful fielding of the BAWS integrated with the prototype Joint Biological Point Detection System led to quantity procurement from industry. The laboratory has continued to transfer the technology to industry and ahs developed improved fabrication technology for the microchip laser.

The laboratory is utilizing the BAWS technology to obtain background data for environments other than typical military locations.

Lincoln Near Earth Asteroid Research Program

The Lincoln Near Earth Asteroid Research Program (LINEAR) program operates a wide-area asteroid search program employing an advanced electro-optics search system originally developed for Air Force-sponsored space-surveillance applications. Now the world's leader in asteroid discoveries, LINEAR searches 15,000 square degrees of sky per month to a limiting magnitude of 19.2 and has generated 4.4 million observations during the time period

of March 1998 through July 2001. These account for over half of all observations in the Smithsonian Minor Planet Center archives, and 70 percent of the reported observations generated since March 1998. This effort has resulted in discovery designations for 666 near-Earth asteroids of a total 1395 known (the first dating back to 1898), 62 comets, and over 110,000 main-belt asteroids.

The wide sky coverage of LINEAR provides a much more thorough search than other surveys and reveals a previously unrecognized number of near-Earth objects having orbital paths that are highly inclined relative to the plane of the solar system. Professor Richard Binzel and graduate student Scott Stuart in the Department of Earth, Atmospheric, and Planetary Sciences, are using this data to refine the orbital distributions for the near-Earth object population.

Earth Observing 1 (EO-1) Mission: Advanced Land Imager

Lincoln Laboratory is responsible for the design, development, and flight validation of the Advanced Land Imager (ALI) that was launched on the NASA Earth Observing-1 mission, on 21 November 2000. ALI has demonstrated advanced technologies to meet NASA's Earth Science Enterprise needs in the 21st century. The new technologies dramatically reduce the size, weight, and power of ALI versus the LANDSAT-7 Enhanced Thematic Mapper, at the same time increasing the instrument's sensitivity and resolution. ALI has been operating successfully on orbit, returning on average eight images per day. The images are being used to validate the instrument performance by the Laboratory design team as well as by thirty independent Science Validation Teams. With this success, NASA has selected ALI as the benchmark design for the LANDSAT Data Continuity Mission, currently in the planning stage.

Multi-Sensor Fusion and Exploitation

With this increase in data from advances in sensor technology that cover larger areas, there is an associated challenge to automate the data reduction process. Lincoln Laboratory has focused on automation techniques that enable both scene visualization and target detection. Scene visualization is accomplished by registering the multi-modality data to a three-dimensional site model and fusing the layers by using a model of the human visual system. Image mining techniques are applied to the fused data to automatically detect terrain features like roads, buildings, and trafficable areas. This information can then be used as contextual information for advanced target-recognition algorithms. In the last year, an integrated visualization system to support the intelligence community was deployed. This system provides a capability to visualize color-fused three-dimensional scenes of areas of interest.

MISSILE DEFENSE

Ground-Based Midcourse Defense Program

The DoD has a program to develop and examine a system to defend the U.S. against a limited ballistic missile attack. Lincoln Laboratory is supporting the Ground-Based Missle Defense (GMD) program at both the system and element levels. System work focuses on evaluating discrimination architecture against postulated and potential countermeasures. Additional effort emphasizes characterization and assessment of early warning radar, prototype ground based radar, and exoatmospheric seeker performance, primarily through design and analysis of flight tests.

Theater High-Altitude Area Defense Program

The Theatre High-Altitude Area Defense (THAAD) system is currently in the engineering and manufacturing development phase. The system is designed to provide large-area defense against theater ballistic missiles. Lincoln Laboratory provides detailed characterization of the radar's performance. In addition, the laboratory conducts testing and analysis of the baseline decision algorithms, as well as continuous development and transfer of discrimination algorithm upgrades for the THAAD radar.

Navy Theater Air and Missile Defense Program

Over the past several years Lincoln Laboratory and the Advanced Electronic Guidance and Instrumentation System (AEGIS) program office have been developing a theater ballistic missile defense (TBMD) capability. This capability is separated into two programs: a Navy Area system (lower tier) and a Navy Theater-Wide (NTW) system (upper tier). Both programs differed greatly from the current AEGIS anti-aircraft warfare capability. The challenges associated with detection, discrimination, and handover of hostile targets within the TBMD complex have been an area of active laboratory work. The laboratory has developed algorithms for synthetic wideband radar measurements and algorithms to improve IR focal-plane performance, which includes the use of a two-color focal plane. Extensive experiments were conducted this year using a wideband radar data collection system and a captive-carry seeker.

Space-Based Infrared System Surrogate Test Bed

Lincoln Laboratory has been selected to lead a multi-year effort to use existing space-, air- and ground-based optical assets to emulate the space component of the nation's proposed Ballistic Missile Defense System. The Space-Based Infrared System (SBIRS) Program is responsible for developing and deploying a constellation of operational satellites needed for detecting, tracking, and aiding in the discrimination of all of the lethal and benign objects deployed by a ballistic missile launched against the United States and, potentially, its allies. The SBIRS Surrogate Test Bed is envisioned as a low-cost, low-risk, rapidly deployable system designed to assure the collection of SBIRS-like data during ballistic missile flight tests. The laboratory designed and operated Midcourse Space Experiment satellite's Space-Based Visible sensor, which will be utilized with other sensors. In addition, a data fusion processing system will be deployed and tested at the Maui High Performance Computing Center in late 2003. The SBIRS Surrogate Test Bed will demonstrate and validate the concept of SBIRS and will demonstrate many functions of the SBIRS system, prior to the planned launching of the first operational satellites in 2006.

Theater Missile Defense Critical Measurements Program

The Theater Missile Defense (TMD) Critical Measurements Program (TCMP) employs a sequence of flight tests executed at the Reagan Test Site (formally called the Kwajalein Missile Range) to provide IR and radar measurements that address critical TMD system-level issues. Lincoln Laboratory supports TCMP in four task areas: mission planning and integration; payload development; flyaway IR sensor development; and data analysis. The TCMP-3B campaign was successfully completed in February 2001. The data collected are being used to develop new discrimination algorithms for the missile defense acquisition programs.

AIR DEFENSE TECHNOLOGY

Airborne Seeker Test Bed

The capabilities of modern air-defense missile systems have been severely challenged by the advent of low-observable vehicles and modern electronic countermeasures. The Airborne Seeker Test Bed (ASTB) is an instrumentation platform developed by Lincoln Laboratory to investigate these challenges and identify appropriate seeker architectures and signal processing algorithms for dealing with them. The ASTB is based in a Gulfstream II aircraft and provides high-fidelity RF and IR reference instrumentation sensors that are used in parallel with special-purpose wing-pod payloads carrying production seekers or sensors under test. The combination of the system under test with the instrumentation sensors yields insight into the performance of sensor systems and advanced signal processing algorithms.

This year's ASTB activities include one major test campaign and infrastructure upgrades. The test campaign was conducted in Nevada to evaluate the effectiveness of electronic countermeasures against a modern air-to-air missile system and to verify readiness to operate with a modern surface-to-air missile system. The latter will allow flight testing of target intercepts in which ground-based tracking radar and the on-board RF seeker share data and act as an integrated system. Because the ASTB also carries IR focal-plane arrays and IR seekers, these and previous flight tests provide data to evaluate the degrading effects of background clutter on the IR detection and tracking of target aircraft. Another new RF seeker has been received and is being integrated into a flight-test configuration; completion is expected at the end of 2001.

Airborne Countermeasures Test System

The Airborne Countermeasures Test System (ACTS) is a Falcon-20 business-class jet converted to operate either as a versatile target for testing of current and future air-defense missile systems or as a GPS jamming platform. The ACTS can provide a variety of electronic countermeasures and can be configured to operate at L-band, X-band, or Ka-band. The ACTS has been operating since 1997, and this year flight-test campaigns were conducted for DARPA and the Air Force.

INFORMATION EXTRCTION

Embedded Digital Systems

Several existing and planned DoD systems are designed on the basis of commercial-off-the-shelf (COTS) technology. The DoD is relying on acquiring and leveraging embedded digital hardware from COTS vendors. Even though the hardware is dominated by COTS technology, the software is application specific. The DoD has recognized the need to standardize the software development for advanced high-performance systems. Lincoln Laboratory has been asked to lead a DoD-wide software standardization initiative to develop and demonstrate orders of magnitude reduction in software development efforts. The laboratory is working with Northrop Grumman,

MITRE and the Air Force Research Laboratory, to quantify, via prototypes demonstrations, the improvements achieved in reducing software development time and cost.

Precision Targeting Via Collaborative Networking
The ability to accurately geo-locate, identify, and engage enemy mobile air-defense systems is very difficult due to the ability for these threats to shoot and move on a very short timeline, typically five minutes or less. Lincoln Laboratory, under DARPA sponsorship, is responsible for demonstrating accurate geo-location and identification by leveraging recent dramatic advances in wireless and fiber networking. The demonstration will include airborne assets, a high-speed fiber network referred to as BosSNet (Boston South Network), and advances in front-end filtering algorithms and target identification techniques.

Advanced Radar Systems
Lincoln Laboratory is assisting the Navy in the development of systems and technologies aimed at improving ship survivability against airborne threats. For example, an effort is ongoing to demonstrate an upgradeable, expandable, COTS replacement of aging AEGIS computer systems capable of executing exoatmospheric target discrimination algorithms. These efforts include all aspects of the signal processor development, focusing on new algorithms, software portability, and life-cycle support.

Ocean Systems
Lincoln Laboratory continues to provide algorithm improvements to the Los Angeles class submarine fleet. Operator feedback from the testing of the Lincoln Interactive Passive Acoustic Classifier in the fall of 2000 expressed confidence for the first time in the promise of automated aids to classification. In the spring of 2001, Lincoln Laboratory-developed algorithms for mitigating the effects of cable strum in adaptive beam forming were submitted for inclusion in the fall test series. Lincoln Laboratory initiated work on algorithms to exploit the increased vertical aperture to resolve targets in depth and range on a DARPA-sponsored program.

COMMUNICATIONS AND INFORMATION TECHNOLOGY

Next Generation Terrestrial Networks
As part of the Next Generation Internet (NGI) initiative, DARPA has sponsored a unique dark-fiber-communications research and application test bed called BosSnet. BosSnet extends four modern optical fibers from MIT and MIT Lincoln Laboratory to the Washington DC area, enabling terabit per second communication. The test bed became operational in December 1999 and is planned to continue operations for four years. New optical transmission methods are being explored to extend the bit-rate times distance product beyond the current state of the art, resulting in lower installation and operating costs. BosSnet connects to the national DARPA-sponsored Supernet; increasing this national fiber-optic connectivity among researchers.

Military Satellite Communications
The movement of military operations to rapid maneuver, precision strike, and information dominance has resulted in large increases in communications data rate and volume requirements, especially to small mobile or transportable satellite terminals. This year the laboratory continued to develop advanced modulation, coding, and multi-user access techniques to increase efficiency of use of limited allocated bandwidth and transmitter power for future (2010+) satellite communications systems.

Lincoln Laboratory's development of a test bed to demonstrate higher-data-rate waveforms for the DoD's next-generation protected satcom system (Advanced EHF; 2006 launch) has been successfully completed. Efforts are now addressing highly instrumented test terminals and payload simulators. In addition, successful field demonstrations of previously developed protocols for highly efficient transfer of bursty, packetized data traffic over satellites have been conducted. The laboratory has also developed interfaces to permit its satcom facilities to accommodate a heterogeneous mix of input/output devices to support the Services as they field the new medium-data-rate Milstar satcom system. These interfaces are being used for both industrial-factory and post-launch Milstar testing and experimentation.

Army Communications
To provide connectivity between the sustaining base and the fighting forces, an integrated, global communications system is required. While satellite communications can provide the range and terrain independence required of the communication system, a particularly challenging problem is to provide satellite communications to vehicles on the

move. Passing objects such as trees or buildings block the received signal. This year, Lincoln Laboratory developed a data-link algorithm that mitigates these signal outages. This algorithm supports multiple qualities of service so that important time-critical information (such as command and control) receives the highest priority while less time-critical information is queued for transmission.

For very small, low-profile antennas required for on-the-move and portable communications at EHF frequencies, there is a significant advantage for making best use of the available power in the communications channel by employing advanced channel-coding techniques. A novel algorithm and design of a "Turbo Decoder" was developed that significantly reduces the required signal-to-noise ratio of the channel while still maintaining the quality of the transmissions. The Lincoln Laboratory-developed decoder is an order of magnitude less in size and complexity than other available decoders. This algorithm is being incorporated into the Army's Single Channel Advanced Milstar Portable (SCAMP) satcom terminal.

Submarine Communications

The application of adaptive diversity combining to improve submarine communications with satellites has continued with the development of an Advanced Technology Demonstration model of the Laboratory-developed buoyant cable antenna. Also, similar techniques are now under development for retrofit into submarine mast antennas.

Smart Sensor Web

Lincoln Laboratory is the system integrator for the smart sensor web, a multi-service, multi-national program. The program is developing a conceptual system design for a tactical information network for the lower-echelon warfighters. An operational test bed has been established at the Military Operations in Urban Terrain Center At Ft. Benning, Georgia. A series of experiments have been planned to evaluate the functional components of such a system. Experiments began in august 2000.

AUTOMATIC SPEAKER RECOGNITION

The Lincoln-developed Gaussian Mixture Model and Universal Background Model approach to speaker recognition has become the *de facto* standard for automatic text-independent speaker-recognition research and applications. In annual international evaluations of speaker-recognition technology performed by the National Institute of Science and Technology, the laboratory system has consistently been one of the top-performing systems. In the latest 2001 evaluation, laboratory systems achieved top performance in five of seven tasks. A new Lincoln Laboratory technique based on using only a small set of words spoken by a speaker has produced an accuracy of >99 percent correct decisions. This technology is being transferred to law enforcement efforts. The Laboratory-developed system is also currently being used in a prototype forensic tool at the FBI's Audio Forensic Laboratory.

Intrusion Detection For Government Networks

Lincoln Laboratory continues to develop and deploy novel intrusion detection techniques and systems into essential government networks. The Laboratory has improved the accuracy of the systems deployed for the FAA, and the Laboratory Battlefield Intrusion Detection System (BIDS) has been selected for deployment into U.S. Army hosts in tactical environments. Two implementations of the bottleneck verification algorithm were developed: one for BIDS for use in a wireless environment, and one for use in a wired environment. Cooperation with Air Force Information Warfare Center has enabled the wired implementation to be successfully integrated with the Air Force's existing intrusion detection system and deployed on the computer networks of nine Air Force bases. The laboratory's bottleneck-verification software has performed well on these networks, detecting attacks with a minimum of false alarms (fewer than 1 per week). Based upon this excellent performance, the software is slated for deployment to all Air Force bases.

AIR TRAFFIC CONTROL

Automation Tools

Lincoln Laboratory is working with the FAA and NASA to enhance air safety, reduce controller workload, and increase airport capacity by developing planning aids for air traffic controllers. In a NASA-sponsored effort, Lincoln Laboratory is integrating advanced weather products from the Lincoln Laboratory-developed Integrated Terminal Weather System (ITWS) into the Center Terminal Automation System (CTAS) developed by NASA. CTAS helps coordinate activities between arrival controllers located at en route centers and final-approach controllers located at radar control facilities. The initial work is integrating wind field products from the ITWS to improve aircraft

trajectory estimates. Work is also under way on the use of ITWS convective weather products in CTAS for determining weather-impacted routes.

Surveillance Technology Improvements

The laboratory is collecting and analyzing field-test data to evaluate the performance of a new solid-state Airport Surveillance Radar (ASR-11) for use at second-tier civil and military airports in the United States. The laboratory is assisting with design modifications to the current Airport Surveillance Radar (ASR-9) in use at the nation's busiest airports that will permit the ASR-9 to continue operation to 2020.

Aviation Weather Detection and Prediction

Technology transfer for major aviation-weather-information systems developed at the laboratory has proceeded. The laboratory-developed Integrated Terminal Weather System is undergoing operational test and evaluation at Kansas City and Houston prior to national deployment. A Medium Intensity Airport Weather System (MIAWS) has been developed to provide real-time, high-resolution information on thunderstorm location and movement at small airports. MIAWS utilizes data from the National Weather Service's Doppler weather radars, together with laboratory-developed data quality editing and storm-tracking algorithms. The laboratory has deployed a Corridor Integrated Weather System (CIWS) covering the busy Cleveland, Chicago, and Indianapolis en route centers to facilitate traffic management during thunderstorm activity. CIWS integrates data from over 20 radars to provide timely, high-quality surveillance of thunderstorms and utilizes Lincoln Laboratory-developed thunderstorm forecasting technology to provide accurate 30-minute to 1-hour forecasts of future air-route impacts. Dedicated displays at all the major ATC facilities, coupled with Internet access to the CIWS products for airline operations personnel provide common situational awareness for all the participants in tactical decision making during thunderstorm impacts.

ELECTRONIC DEVICES

CANARY B-Cell Sensor for Rapid, Sensitive Identification of Pathogens

The CANARY B-cell sensor is a device that uses B cells, or white blood cells, as the detector elements to rapidly identify pathogenic organisms. Lincoln Laboratory has genetically engineered B cells to bind to the pathogens that cause foot-and-mouth-disease, Venezuelan equine encephalitis, plague, and tularemia, and to emit photons starting in less than one second after the binding occurs. The photons are detected by using a photomultiplier tube and simple readout electronics. Over the past year, this apparatus has demonstrated the best combination of speed and sensitivity for any known pathogen-identification test (limit of detection of a few particles in a few minutes or less). In addition, the consumables cost per test is estimated to be one to three orders of magnitude lower than that for present medical diagnostic identification tests.

Microscopy at Sub-200nm Wavelengths

Lincoln Laboratory has recently constructed a prototype optical microscope operating at the very short ultraviolet wavelength of 193 nm, and has demonstrated its high sensitivity in detecting traces of materials on various surfaces. Imaging in the sub-200nm wavelength range opens up new possibilities, since it takes advantage of different optical properties than those at longer wavelengths. As a result, the reflectivity is quite different, and the chemical sensitivity of the imaging can be vastly increased. For instance, a layer of organic polymer as thin as one nm can be easily observed on a silicon or quartz substrate when using this microscope, whereas it is completely undetectable with visible or near-ultraviolet radiation. The calculated enhancement in optical contrast at 193 nm compared to visible microscopy can exceed two orders of magnitude. In addition to this improved chemical sensitivity, microscopy at 193 nm affords improved spatial resolution by virtue of straightforward scaling of diffraction-limited imaging with wavelength. As imaging with infrared radiation reveals unexpected features, so imaging in the deep ultraviolet may open new opportunities in detecting trace contaminants in the microelectronics industry and forensics, and may enable the observation of unexpected structures in other fields such as molecular biology.

Burst-Rate Imager

Burst-rate charge-coupled device (CCD) detectors are being developed at Lincoln Laboratory for Los Alamos National Laboratory's (LANL) Nuclear Stockpile Stewardship Project. The two-dimensional imager captures and locally stores four sequential images at a 1.6 MHz frame rate (one 512-by 512-pixel frame every 646 ns). The laboratory-developed CCD detectors will be integrated next year into the diagnostic sensor at the LANL Dual Axis Radiographic Hydrodynamic Test facility currently under construction. Besides fast shutter times, the high

sensitivity (100 percent fill factor and 60 percent quantum efficiency) of these sensors is critical to ultra high-speed electronic imaging.

Ladar Detector

Lincoln Laboratory has developed a single-pulse, three-dimensional imager for laser radar (LADAR) applications. Thirty-two by thirty-two pixel arrays have been fabricated by hybrid combining of sensitive Geiger-mode avalanche photodiodes with fast CMOS timing circuits. A short (fraction of one ns) laser pulse actively illuminates a scene, and only a single photon per pixel is needed to measure the range to a target. The return time of the first photon returned for each pixel is converted directly to a digital word by the CMOS counter in that pixel. This approach both provides the range and avoids the analog signal processing chain found in most LADAR detectors. The depth resolution of the LADAR detector is six cm and can be improved to one cm. This detector architecture is suitable for three-dimensional imaging of fast moving targets from small platforms where power, weight, and size are constrained.

Advanced Thermoelectric Materials

Self-assembled quantum dots provide a mechanism to reduce the electron density of states (DOS) in a material by locally confining the electrons on a very small scale, ~10 nm. One result of this enhanced electron confinement is a significant increase in the Seebeck coefficient, which relates the heat transport to the electric current passing through a p/n junction. This year, 10,000 layers (~ 0.1 mm) of quantum dots superlattices (QDSLs) have been epitaxially grown at Lincoln Laboratory by using the lead-salt material system, PbTe/PbSeTe. This material system allows full exploitation of the enhanced Seebeck effect to build high-efficiency thermoelectric coolers. These bulk lead-salt QDSL materials have been used to build the first functioning thermoelectric cooling device based entirely on 3-D quantum-structured materials.

More information about Lincoln Laboratory can be found online at http://www.ll.mit.edu/.

David L. Briggs

DEAN, SCHOOL OF ARCHITECTURE AND PLANNING

The School of Architecture and Planning deals with a far wider range of fields and issues than its name might suggest. In addition to the Department of Architecture (the oldest such department in the country), and the Department of Urban Studies and Planning, it houses the Program in Media Arts and Sciences, the Media Laboratory, the Center for Real Estate, the Center for Advanced Visual Studies, and the Aga Khan Program for Islamic Architecture. There are many cross-connections among these units, and together they address issues of the human environment—in all its aspects—on a very broad front.

The School was extremely active during the 2000–2001 academic year. There were particularly exciting developments in faculty hiring, in initiation of new research and teaching ventures, and in improvement of physical facilities.

FACULTY

The strength of the faculty continued to grow during 2000–2001, and there were important faculty appointments in all units of the school.

In the Department of Architecture, Takehiko Nagakura, Associate Professor of Design and Computation, was granted tenure. Wendy Jacob was named the Class of 1947 Career Development Professor for a three-year term. J. Meejin Yoon, who trained at Cornell and Harvard, was chosen as a new Assistant Professor of Design. Structural engineer John Ochsendorf was selected to join the Building Technology group and will arrive in July 2002 following completion of his current research project. Heghnar Watenpaugh, who earned a Ph.D. at UCLA, was appointed Assistant Professor in the History, Theory, and Criticism group.

In the Program in Media Arts and Sciences (MAS) Hiroshi Ishii, director of the Tangible Media Group, was promoted to Associate Professor with tenure. Bruce Blumberg, head of the Synthetic Characters Group, was promoted to Associate Professor without tenure. Isaac Chuang, from IBM's Almaden Research Center in California, was appointed Associate Professor. He heads the new research group on *quanta* which explores the fundamental building blocks of physical media, information technology, and intelligence.

Nicholas Negroponte, long-time Director of the MIT Media Laboratory, announced that he would take on the newly created position of Senior Director, focusing on external and international relations. Walter Bender, head of the Electronic Publishing Group, was named Executive Director in charge of internal growth and development of research and sponsor relations. Sony Career Development Professor John Maeda, head of the Aesthetics and Computation Group, was named Associate Director of design and communication. Rudolph Burger, an expert in digital photography and a former Xerox Corporation Vice President, was named Chief Executive Officer and Director of Media Lab Europe (MLE) based in Dublin.

In the Department of Urban Studies and Planning (DUSP), Diane Davis was appointed Associate Professor of Political Sociology. Her research focuses on the politics of urban policy and history, cities and national development, and policing and public security. Lorlene Hoyt was hired as an Assistant Professor. He specializes in municipal geographic information systems, business improvement districts, and public service systems.

In December, Chairman Blake Eagle left the Center For Real Estate (CRE) to become President of the National Council of Real Estate Fiduciaries. John T. Riordan, former president of the National Council of Shopping Centers, became the new Chairman in June.

An overriding concern and goal for the School is to increase the diversity of our faculty and students. Over the past few years, with help from the Provost's special programs, we've had great success in attracting women and minorities to the School. We continue to apply aggressive recruitment efforts in every faculty search.

SPACE

Plans for the new Media Laboratory Expansion, designed by world-renowned architect Fumihiko Maki, entered the construction documents phase. Construction is expected to commence in April 2002. The complex will house three centers: the Okawa Center for children, learning, and developing nations, a center focused on the underlying science and technology needed to merge digital with physical bits, and a center dedicated to arts and expression. The new center, which will approximately double the current size of the lab, is scheduled for completion in 2004. Plans for a complete renovation of the lab's existing site (Building E15) are also underway. In order to accommodate the lab's recent growth there is a newly established temporary "outpost" at One Cambridge Center.

The last phase of the School's master plan—the renovation of offices, project rooms and the Computer Resources Labs of the Department of Urban Studies and Planning—was approved and is currently near completion. Classroom space for the newly configured Teacher Education Program was allocated to the School and renovated during the year. Graduate student studio spaces for the Visual Arts programs are in the process of renovation and will be completed by fall 2001. The work adds security measures and provides much needed general upgrading. These changes will provide art school-standard studio spaces and a common teaching area for the graduate program.

At the Center for Real Estate (CRE), the central office was redesigned to provide quieter and more private workspace for support staff. Plans were made to update carpet, paint, and furnishings in the student lounge and adjoining conference room.

EDUCATIONAL INITIATIVES

Departments throughout the School continued to innovate in response to emerging conditions and opportunities.

The ArchNet project evolved rapidly over the course of the year. Launched in 1999, ArchNet is an extensive online community resource dedicated to architecture, urban design, and urban development with a special focus on the Islamic world. It is accessible via the Internet to scholars, practitioners and interested non-specialists. Currently over 1,700 online subscribers from more than 65 countries are utilizing ArchNet's resources and virtual workspaces. Detailed information can be found at http://archnet.org/.

In the Department of Architecture, the undergraduate program was strengthened by a newly implemented studio sequence. The MArch Committee reorganized its curriculum resulting in a greater emphasis on design, a stronger integration of multi-disciplinary subjects, and a better model for selecting and developing concentrations. A student exchange began with the Technical University Delft, overseen by faculty member Paul Lukez. New international student internships began with the distinguished firms of Renzo Piano, Takenaka Corporation, and Ove Arup & Partners with options for future opportunities at Norman Foster in London and Behnisch and Behnisch in Germany. The Building Technology group started working on a five-year project in collaboration with Cambridge University on sustainable buildings in the UK. Students expanded the Architecture Student Council (ASC) and now have representatives active on the Department Council, the MArch Curriculum Committee, and the Studio Faculty Committee.

The Aga Khan Program for Islamic Architecture (AKPIA) began making the transition from an outreach-based program to an academic-based program, under the leadership of Aga Khan Professor Nasser Rabbat.

The Program in Media Arts and Sciences (MAS) enrolled 24 students in its alternative freshman year program during the 2000–2001 academic year. The students signed up for recitation sections in two core freshman subjects, pursued Media Lab UROP research projects, and participated in two new MAS undergraduate subjects on graphic design and research methods. MAS continued to work towards the goal of establishing a full-fledged undergraduate program.

On July 24–25, 2000 Media Lab Europe (MLE) was launched in Dublin, Ireland with a major symposium attended by over 400 people from the academic, business, and arts communities. MLE initiated more than ten collaborative projects with Irish Universities including "Intelligent Sensing Systems for Science Education and Bio-Monitoring" and "A Multilingual Development Environment for Speech Technologies." Current research groups at MLE include Affective Feedback, Nanostructures, and Everyday Learning. In October over 200 people from 40 nations came to the Media Lab in Cambridge to open Digital Nations, a new consortium dedicated to helping people in developing areas solve local problems by learning and applying digital technologies. In June 2001, the lab announced a one-year exploratory project with the government of India to create Media Lab Asia. The mission of this new initiative would be to work with the Indian government and local non-government organizations to apply sophisticated emerging technologies to the daily problems of India's poorest and least educated people.

The Department of Urban Studies and Planning (DUSP) was named the "premier planning school in the U.S." in the reaccredidation report for its Masters in City Planning (MCP) Program. The Ph.D. Committee addressed admissions and curriculum issues while the Undergraduate Committee introduced several new subjects in response to recent restructuring. In October the department participated in a joint teaching studio on "Open Design Methods" with the Technical University Delft (TUD) and also began discussions for a multi-year joint research effort with TUD. The Department also launched plans for a series of annual joint studios with the University of Cambridge. The Housing, Community and Economic Development (HCED) Group investigated two new issues: the role of community organizing in place and faith-based organizations and the combination of physical and economic development in neighborhood commercial revitalization. The Environmental Policy Group (EPG) offered a new course in environmental planning which provided funding for students to travel to the Philippines to work on ecological protection issues. Professor Balakrishnan Rajagopal helped establish MIT's Program on Human Rights and Justice, a joint effort between DUSP and the Center for International Studies. The program, which hosts a speaker series, aims to develop student internships and collaborative research projects with the United Nations and other agencies.

At the Center for Real Estate (CRE), the sixteenth summer of professional development courses brought 296 attendees to campus during the summer of 2000 to enroll in nine courses, including two new courses on "Structuring Complex Real Estate Transactions" and "Advanced Real Estate Negotiations." The center's 2001 Summer Institute offered a new course on "Benchmarking Real Estate Investment Management and Performance Measurement." In the professional degree program, course content continued to evolve as the real estate industry changed, especially in the areas of finance and real estate capital markets.

Eight students joined the Center for Advanced Visual Studies (CAVS) as UROPS this year. Two new courses on Special Effects for New Cinema and Narrative and Central Conflict Theory were offered. Research Scientist Glorianna Davenport and Professor Stephen Benton conducted a weekly seminar series, MAS.878 Experiences in

Interactive Expression which brought artists Ken Goldberg, Jack Ox, Christa Sommerer, Tetsuro Fukuhara, and Christian Boustiani to MIT for a day of discussions with students and faculty. The seminar culminated in an exhibition of student-produced interactive installations at CAVS.

EVENTS AND AWARDS

The academic year showcased innovative work from within the School as well as offering us the chance to learn from leading international figures in design.

This year in the Department of Architecture the Pietro Belluschi lecture was given by Edward Cullinan. Mamoru Kawaguchi delivered the fourth Felix Candela lecture. The Arthur H. Schein Memorial Lecture was given by Herman Hertzberger. The Architecture Lecture Series included distinguished guests Santiago Calatrava, Peter Eisenman, Anthony Vidler, Marlon Blackwell, Shigeru Ban, Sheila Kennedy, Fumihiko Maki, Elaine Sturtevant, Elizabeth Diller, and Ricardo Scofidio. John Fernandez was given a Graduate Teaching Award by the Graduate School Council. Edward Levine won a competition for a public art project in Fairmont Park, Philadelphia. Krzysztof Wodiczko concluded a significant public projection about border issues in Tijuana, Mexico. In November 2000, Joan Jonas had a major retrospective exhibition and performance series at the Städtisches Museum, Stuttgart. In September 2000, Stanford Anderson organized an intercontinental conference on the work of Eladio Dieste, "Scientific Innovation in Structure and Construction with Traditional Materials: The Eladio Dieste Symposia."

In the Program in Media Arts and Sciences, Justine Cassell won a 2001 Edgerton Award. Joseph Jacobson was one of nine winners of the 12th Annual Discover Awards. Pattie Maes was awarded the Lifetime Achievement Award by the Massachusetts Interactive Media Council. Marvin Minsky won the Benjamin Franklin Medal by The Franklin Institute in Philadelphia, PA. John Maeda received the 2001 Design Management Institute Muriel Cooper Award and was inducted into the prestigious Alliance Graphique Internationale. The *Expressive Footwear* project won a 2000 *Discover Magazine* Award for Technical Innovation. John Maeda and Joseph Paradiso were chosen to head a team to create a special exhibition, *Workspheres*, on the role of design in the work environment at the Museum of Modern Art in New York. Their creation, entitled *Atmosphere*, is a multifaceted communication tool for navigating and organizing information.

In the Department of Urban Studies and Planning (DUSP), faculty and students in the City Design and Development Group (CDD) organized and participated in two successful colloquia, "Metropolitanism in Practice" and "Urban Narratives: Making the City Speak." Faculty in the Environmental Policy Group (EPG) hosted two conferences, "Civic Environmentalism Roundtable" and "Regional Sustainable Development Forum." The Environmental Technology and Public Policy Program within EPG launched an environmental justice initiative that includes teaching, research, and capacity building activities. The Housing, Community and Economic Development (HCED) group hosted a series of seminars featuring Ernesto Cortes of the Industrial Arts Foundation and local community organizers. The Special Program for Urban and Regional Studies (SPURS) organized a seminar, "Global Forces and Local Spaces." The Center for Reflective Community Practice (CRCP) initiated the Reflective Practioner Fellowship, sponsored several symposia, and offered its first community digital storytelling workshop.

The Aga Khan Program for Islamic Architecture (AKPIA) hosted a well attended two-day conference "Exploring the Frontiers of Islamic Art and Architecture." Visiting Assistant Professor Nuha Khoury led a seminar on "Religious Architecture in Islamic Cultures." Visiting Associate Professor Jerrilyn Dodds taught a seminar on "Nonwestern Architecture—Exchange Theory and the Architecture of Pluralistic Societies." Visiting Professor Hasan-Uddin Khan conducted a seminar on "Conservation—Extreme Architectural Conservation in the Face of Globalization, War and Tourism."

The Center for Real Estate (CRE) hosted a lively, well-attended members meeting in November featuring a discussion about the impact of the Internet and other new technologies on the demand for real estate. A conference in May, "Development Finance: Irrational Conservatism," examined the constraints on capital available for development. Robert Danzinger, retired Chairman of Northland Investment, led the popular Real Deals speaker series for the fifth year in a row.

At the Center for Advanced Visual Studies (CAVS), Director Emeritus Otto Piene was honored with a retrospective at the new 24-Hour-Kuntsmuseum in Celle, Germany. Fellow Hishram Bizri's film "City of Brass" was chosen for screening at the Museum of Modern Art and the Milan International Film Festival. Visiting Fellow Kelly Heaton won the 2001 L'Oreal Prize in the Art and Science of Color for her MIT thesis "Physical Pixels" and was also one of ten New England artists selected to exhibit her installation "Reflection Loop" at the DeCordova Museum.

The Marvin E. Goody prize for a master's thesis that advances the building arts was awarded jointly to students Lora Kim, Amina Razvi, and Asheshh Saheba. The Ralph Adams Cram Award for outstanding interdisciplinary work at the Master's level was presented to Garyfallia Katsavounidou for her thesis "Invisible Parentheses: Mapping (out) the City and its Histories."

More information about the School of Architecture and Planning can be found online at http://sap.mit.edu/.

William J. Mitchell

DEPARTMENT OF ARCHITECTURE

The Department of Architecture has as its core activity the professional Master of Architecture degree program. The faculty includes architects, urbanists, building technologists, historians of art and architecture, artists, and various specialists in areas of architectural research. The presence of this entire range of faculty is premised on assuring a professional program of both depth and breadth. The strength and well-being of the Master of Architecture program is fundamental in maintaining and enhancing our position as one of the world's most respected professional schools of architecture.

The department is quite unusual in, first, including the many disciplines of our faculty within the department, and then, still more significantly, creating the opportunity for each discipline to have specialized advanced degree programs. We incorporate outstanding research and teaching programs in each of these groups: Building Technology; History, Theory and Criticism (HTC); Visual Arts; and the internally differentiated Architectural Design group. Under the last rubric, beyond the obvious attention to architectural design, are our programs in urban design, computation and design, shape grammars, and design technology. We have been gratified to see excellent design work by our undergraduates in recent years. Notable strengths of the department that cut across the discipline groups are our devoted teaching, the grounding of architecture in both social and material issues, interdisciplinarity, and the remarkable internationalism of faculty, students, teaching and research.

The discussion below is organized by discipline group, followed by individual topics that cross discipline areas.

ARCHITECTURAL DESIGN

The statement below was prepared for the accreditation of our professional architectural design degree, but also emphasizes the interconnecting roles of all discipline areas in the department.

It is a commonplace that new theories and new technologies are changing our conception of what architecture can do and how architects conceive their tasks and accomplish them. The unique position of the MIT Department of Architecture is that we survey the development of theory from a decades-old departmental commitment to viewing such developments through the long lens of the history of criticism. We also view technology within an Institute which for a half-century has profoundly shaped and investigated technology's role in society. So we are open to—indeed are enthusiastic about—new technologies and theories. But we also feel impelled to test the results of our designing against long-held social and environmental values. As we embrace new conceptions of architecture, we demand of ourselves that our designs have the qualities of space, light, air, tectonic soundness, and place that allow for appropriate, even poetic, inhabitation.

In September 2000 we started the new undergraduate studio sequence that was planned in the preceding year. During 2000–2001 a committee broadly representing the department discipline groups re-organized the MArch curriculum. Notable emphases of this new curriculum are increased emphasis on design, greater integration of subjects from different disciplines taken in the same term, and a stronger model for the selection and development of "concentrations."

Beginning students (undergraduate and graduate) build up modeling and drawing skills (conventional and digital) in subjects conceived for those purposes and by focusing those skills on an expanding range of ideas that the students must synthesize in their studio projects. The first semester of Level II extends the core studio sequence for graduates and qualified undergraduates with a focus on tectonics—the making and the resultant expression of construction and architecture. Starting in 1999–2000 we continued the core sequence into the spring term of level II. During that same term, MArch students develop a "concentration," a particular field of inquiry, which they continue to pursue through closely-focused design "workshops" and course-work in this and other departments.

Having "graduated" from the core sequence, MArch students in Level III choose that combination of diverse studio offerings which best meets their individual needs and desires. The insights gained in these studios and the concentration culminate in the final semester with the MArch students' theses.

Special opportunities for project-generated student travel are a continuing strength of the department. Shun Kanda again led an extended summer study trip in Japan. The fall urban design studio in Washington, DC was a notable success. Jan Wampler, Reinhard Goethert and Dennis Frenchman conducted a workshop in Bhutan. Thanks to the generosity of alumni (Ann Macy Beha, Louis Rosenberg, John Schlossman), students also pursue individual research studies in the United States and abroad.

A hallmark of studio education at MIT is that instructors propose to their students not merely a project but a process by which that design might be accomplished. Our faculty employ a shared set of themes as vehicles for advancing their pedagogies. Here are those themes, not imposed by departmental fiat, but observed and endorsed by all of us in mutual consultation:

- Tectonic Expression. We find among ourselves a poetic and pragmatic interest in how materiality, the manner of construction, and the means of managing natural forces (gravity, climate, airflow...) might be expressed.
- Light and Inhabitation. We feel that attention must be paid to the capacity of light to transform and model space in ways appropriate to a range of human activities and emotions.

- Building Community. We believe that respect must be accorded to the identity and social needs of inhabitants of places, both to establish private territories for them, and to enhance their abilities to participate in the public realm.
- Cultural Heritage. We respect the value of cultural difference, and we seek strategies that preserve the legacy of artifacts and customs from the past while addressing the pressures and opportunities of the present.
- Urbanism. We are acutely aware of architecture's ability to contribute spatially, symbolically, and functionally to the shared but divergent social and economic life of cities.
- Engaging the Landscape. We understand the impact of buildings as material and experiential extensions of the land. We thus pay particular attention to the impacts that designed environments have on natural systems—and vice versa.
- Sustainability. We feel a concern for the conservation of natural resources, not just in terms of the efficiency of the buildings we design and the practices our buildings foster among their inhabitants, but in terms of larger practices like settlement and transportation.
- Virtual Environments. We are fascinated by the use of digital media to study and represent physical spaces and phenomena. We recognize the opportunity such media afford to design sites, software, and protocols that may foster a sense of inhabitation, of place, in cyberspace.

The noted Indian architect (MIT alumnus) Charles Correa made the transition from visitor to what will be an annual one-term position on our faculty. An emerging American architect on the faculty of the University of Arkansas, Marlon Blackwell, taught a very successful spring studio. The distinguished Japanese architect Fumihiko Maki, the celebrated architect/engineer Santiago Calatrava, and the English architect Ted Cullinan all taught with us briefly. There were also studios by excellent local architects: Maryann Thompson, Carol Burns, and Kyu Sung Woo. Engagement with strong local practitioners continues next year with the return of Burns and the appearance of Hubert Murray and the now widely recognized Brian Healy.

Admissions results for the professional MArch were again strong after some disappointments in the previous year. Students applying and admitted at level I (the beginning of our graduate program) come almost wholly from the most prestigious private colleges and universities. As usual our principal competitor was Harvard with Yale strengthening in recent years. This spring we won five of our top nine applicants, ten of 16. The remainder of our admittees were not ranked, but we overshot our target of 14 students without going to our waiting list. The advanced standing admissions at level II have been consistently strong. This year we returned to the outstanding results of two years ago. This year we won four of the top five; eight of the top ten, and an additional 14 from 24 unranked applicants. We were more substantially oversubscribed here without going to the waiting list. Most of these students come from major public universities, here and abroad. Harvard is the main competitor here as well.

This year Takehiko Nagakura, a specialist in digital representation of architecture, was granted tenure. Roy Strickland is moving on to a position that is very appropriate to his strengths at the University of Michigan. A search for new assistant professors of design netted an impressive young woman architect, J. Meejin Yoon (trained at Cornell and Harvard).

Topics of research by faculty in Architectural Design include: sustainability (Andrew Scott); visualization and representation (Julie Dorsey); shape grammars (George Stiny, Terry Knight); "Workplace of the Future" and design thinking (William Porter with Fernando Domeyko and others); computation and unbuilt architecture (William Mitchell, Takehiko Nagakura); StudioMIT project (William Mitchell); design in developing countries (Jan Wampler, Reinhard Goethert); urban design (Charles Correa, Michael Dennis, Julian Beinart); urban morphology (Paul Lukez); the American landscape (William Hubbard); cities and landscape, photographic representation of landscape (Ann Spirn). Research has been well represented in publications from book chapters and journal articles to news articles.

Established practices are conducted by Charles Correa, Michael McKinnell and Michael Dennis. Smaller practices include those of Ann Pendleton-Jullian, Andrew Scott, Jan Wampler, Fernando Domeyko, Shun Kanda, and Paul Lukez.

Our special association with the offices of Renzo Piano in Genoa and Paris is off to a strong start with the first three annual student internships. The students of the two completed internships, Andrew Jonic and Junko Nakagawa, both won high praise from their Piano colleagues first in Genoa and then in Paris. Similar relationships have started with the Takenaka office in Tokyo and the engineering office of Ove Arup & Partners in London. Other such relationships are being explored with the architectural offices of Norman Foster in London and Behnisch and Behnisch in Stuttgart. These are all among the most distinguished practices in the world.

For some years we have had an exchange program with the department of architecture at Cambridge University. With the advent of the general MIT/Cambridge exchange, we are now engaged in a major joint academic effort. This year we began an exchange of students with the Technical University Delft, including our undergraduates. Paul Lukez initiated and conducts the Delft exchange.

BUILDING TECHNOLOGY

The Building Technology (BT) group continues a strong research record and specialized graduate instruction. Critical reflection is being directed toward enhanced teaching both at the undergraduate and professional architecture levels.

The new major effort of the BT group is a five-year project with Cambridge University on sustainable buildings in the UK with emphasis on natural ventilation and advanced technologies such as PV panels. John Fernandez initiated research on materials and building assemblies with particular attention to fiber reinforcement and textile composites. Leon Glicksman, Qingyan Chen, and Les Norford, joined by the architect Andrew Scott, continue on major research and design work in China involving energy issues and environmental sustainability at several levels: materials, dwelling units, and the site organization of large housing developments. Residential demonstration projects are in Beijing, Shanghai, and Shenzen. Collaboration with Tsinghua University and the Chinese Ministry of Construction. Glicksman and Chen conduct research through our laboratory for the study of indoor air quality, thermal comfort, building energy analysis, and heating ventilating, and air-conditioning (HVAC) system control and design. This includes new research on natural ventilation in US applications. Norford and Julie Dorsey are working on a computational tool to aid architects in complex lighting designs. A new initiative is that of Norford and Glicksman to develop sustainable guidelines for MIT's new and refurbished buildings. There is also collaboration with Harvard's GSD on a web site for advanced building envelope systems.

We anticipate with great pleasure the arrival of a new young structural engineer on July 1, 2002. John Ochsendorf was selected one year ago. We agree to wait while he finishes research he is conducting at Cambridge University and in Spain. While Chen's early tenure case was not successful, the BT section with the agreement of the Dean and the Provost will renew his case in 2001–2002. Barry Webb, noted Australian lighting designer, and Carl Rosenberg of Acentech teamed again to teach lighting and acoustics. John Fernandez, completing his first year as Assistant Professor of Building Technology, was awarded a Graduate Teaching Award by the Graduate School Council.

Our sustained good relations with the architect/engineer Santiago Calatrava this year incorporated a special structural morphology workshop with continuing direction by John Fernandez. What most observers consider the most distinguished engineering firm world-wide, Ove Arup and Partners, headquartered in London, continues a close relationship with our department both in architecture and building technology—only enhanced by the status of our former colleague, Chris Luebkeman, as a director of Arup.

As noted above, BT is involved in a long-term program under the Cambridge/MIT association. Research work continues with Tsinghua University and members of the Alliance for Global Sustainability.

HISTORY, THEORY, AND CRITICISM

The faculty and graduate students of the History, Theory, and Criticism (HTC) group continue a strong record of research and publication. Graduates of the advanced degree programs also continue to receive excellent teaching positions throughout the world.

All members of the group regularly contribute to major journals in their fields and/or to catalogs or edited works. Research interests of the faculty include: architecture and urbanism of modern Europe and America (Stanford Anderson and Mark Jarzombek); of Europe and its colonial enterprises (Arindam Dutta); modern European art (Erika Naginski); art/architectural theory and epistemology (Anderson, Jarzombek, Naginski); urbanism in pre-modern Europe, late medieval and Renaissance architecture (David Friedman); medieval and modern Islamic architecture and urbanism (Nasser Rabbat); and historiography of art and architecture (all). Anderson organized and conducted an intercontinental symposium on the work of Eladio Dieste and innovation with traditional materials (Montevideo and MIT, September 2000). Rabbat organized an Aga Khan Program symposium in the spring of 2001. Mark Jarzombek was awarded a Fellowship from the Canadian Center for Architecture. He is organizing a conference on East European Art and Architecture to take place in October 2001.

Two assistant professors made extremely impressive entries into the teaching and research programs of HTC: Erika Naginski (Ph.D., Berkeley), a specialist in French nineteenth century art and a member of the Society of Fellows at Harvard, with recent appointments at the University of Michigan; and Arindam Dutta, who this year completed a dissertation on architecture and colonial institutions in his native India for the Department of Architecture at Princeton. The search for a junior professor in the Aga Khan-funded line resulted in the appointment of Heghnar Watenpaugh (Ph.D., UCLA), who comes to us from Rice University. When the architect Ellen Dunham-Jones left to become the chair of Architecture at Georgia Tech, HTC lost an effective collaborator in the design studios. However, Dutta stepped into this role effectively. The loss of art historian Michael Leja one year ago occasioned a search at the tenure level. An excellent woman has been chosen and her case will be presented during the fall term of 2001.

As for all units of the department, student financial aid has been and remains a crucial issue. In HTC this appears dominantly as financial packages that will attract the best candidates for the Ph.D. program. What appeared forcefully last year, was that the traditional competitors of the HTC program (Princeton, Harvard, Columbia, and Cornell especially) have greatly escalated their offers to incoming students. This year, by making financial aid offers comparable to our Ivy League competition, HTC Ph.D. admissions were once again very successful. It is imperative that this level of support be regularized if this distinguished part of our department is to thrive. Doctoral students

entering their non-resident research stage continue to win prestigious external research grants. Devoted faculty and staff deserve credit here as well as the winning students.

While HTC has no formalized exchange or other inter-university associations, excellent informal relations are maintained with significant universities with similar interests, including: Cambridge University, ETH Zurich, Technical University of Delft, Technical University of Turin, and the University of Venice.

VISUAL ARTS

The Visual Arts Program (VAP) continues to develop its unique program addressing the relation of artistic practice to new media, performance, architecture, urbanism, and related questions of socio-political content. VAP supports the undergraduate education curriculum of the Institute and also conducts a small graduate program. Its faculty includes a remarkable group of outstanding artists. In a small but selective mode, we are in a position to compete as one of the distinguished schools for contemporary artistic production.

Dennis Adams continues as the valued director of the Visual Arts Program (VAP), but will be on leave in 2001–2002. Wendy Jacob will serve in that role. Adams is in a very productive stage of his own work having just completed a children's garden designed for the Witte de With in Rotterdam as part of an international exhibition of architects, designers, and artists. While on leave, he will be working on public projects in New York, Baltimore, Sao Paulo, and Utrecht. Krzysztof Wodiczko completed a major public projection in Tijuana that incorporated live oral testimonies addressing border issues. Wendy Jacob was named to the Class of 1947 Career Development Professorship for a three-year term, commencing July 1, 2001. Lecturer Reiner Leist taught photography subjects, including a subject reserved for MArch students. The major event of the year, however, was the retrospective exhibition and performance series of Joan Jonas at the Städtisches Museum, Stuttgart (opened November 2000), accompanied by an extensive publication documenting her work.

For 2001–2002, Adams will be replaced by Antonio Muntadas, a fellow of MIT's CAVS and an internationally renowned artist working on the boundaries between new media, art, architecture and advertising. Lecturer Julia Scher will be on leave next year working on a public surveillance projects in Istanbul and Karlsruhe, Germany, and an installation at the Jewish Museum in San Francisco. She will be replaced by Joe Gibbons, a nationally renowned video maker and a recent winner of the Guggenheim Fellowship. Edward Levine won a competition for a public art project for Fairmont Park in Philadelphia and will be working on it while on leave next year. He will be replaced by Christine Tarkowski from the Art Institute of Chicago. Tarkowski works on the relationship of graphic design and architecture. She is currently collaborating with architect, Stanley Tigerman on a Children's Advocacy Center in Chicago.

VAP collaborates with the Graduate School of Design of Harvard in organizing lectures and seminars with internationally-known artists who often appear first in our departmental lecture series.

UNDERGRADUATE PROGRAM

Strong leadership from Associate Professor Leslie Norford, Undergraduate Officer, and Renée Caso, Administrator for Academic Programs, supportive teaching and advising, and a number of administrative initiatives to improve communication and inclusiveness resulted in a more visible presence by undergraduates in the department. A newly-implemented studio sequence strengthened the undergraduate major experience. Undergraduates are represented in the renewed student architectural association. Two undergraduate students were selected to participate in the TU Delft/MIT exchange next year.

AGA KHAN PROGRAM FOR ISLAMIC ARCHITECTURE

The activities of the Aga Khan Program for Islamic Architecture (AKP) are reported separately in this volume. Briefly noted here, however, is the AKP's current transition, under the direction of Associate Professor Nasser Rabbat, from an outreach-based program to an academic-based program, which will be completed in the coming year.

PROGRAM ENROLLMENTS

Course IV counted a total of 277 students: 58 undergraduates, 89 M.Arch., 51 S.M.Arch.S/S.M. without specification, eight S.M.B.T., 4 S.M.Vis.S., 41 resident Ph.D., 20 Non-Resident Ph.D., and 5 Special (non-degree) Students. Course IV-B counted one undergraduate student.

HIGHLIGHTS OF THE PAST YEAR

In the fall term, Stanford Anderson organized an intercontinental conference, "Scientific Innovation in Structure and Construction with Traditional Materials: The Eladio Dieste Symposia," with venues in Montevideo and Cambridge. In the spring term, Nasser Rabbat organized a conference on "Exploring the Frontiers of Islamic Art and Architecture" for the Aga Khan Program for Islamic Architecture.

The Architecture Lecture Series included our own Anne Spirn, Ann Pendleton-Jullian, Charles Correa, and Dean William Mitchell; another special series for MIT by Santiago Calatrava; and lectures by Peter Eisenman, Anthony Vidler, Marlon Blackwell, Shigeru Ban, Sheila Kennedy, Fumihio Maki, Elaine Sturtevant, and Elizabeth Diller and Ricardo Scofidio. Herman Hertzberger presented the Fourteenth Arthur H. Schein Memorial Lecture. Mamoru Kawaguchi gave the Fourth Felix Candela Lecture. Edward Cullinan gave the Belluschi Lecture as keynote speaker

in the Eladio Dieste Symposia. The Building Technology, Visual Arts, and History,Theory, and Criticism programs sponsored discipline-based lecture series which were also open to the public.

Thresholds, published twice a year as a journal edited and produced by students, is increasingly noted for developing diverse architectural themes in each issue. *PinUp,* also wholly edited by students, served the department well as an internal newsletter. *FOUNDATIONS,* a monthly electronic newsletter for alumni, was launched in June and will feature department and alumni news.

The department benefitted from its first visit by a Visiting Committee dedicated solely to the department (that is, now unlinked from the Media Arts and Sciences Program). The visiting committee noted the challenges inherent in a multidisciplinary approach to a complex field; recognized the urgent need for increased student financial aid; recommended re-evaluation of space to meet specific needs of the S.M.Arch.S. students; encouraged the hiring of architects rather than specific specialists; in its searches to continue improvements toward greater gender, racial and ethnic diversity (while noting recent positive progress); emphasized continuing need for communication beween the administration and students and junior faculty.

The department invited visitors and lecturers to contribute their special expertise to the curriculum. Visitors included: Edith Ackermann, Kyu Sung Woo, Marlon Blackwell, Carol Burns, Hasan-Uddin Khan, Maryann Thompson, and Nichole Wiedemann in Architectural Design; Edward Allen and Santiago Calatrava in Building Technology; and Jerrilyn Dodds, John Hanhardt, Henry Millon, John Rajchman, Beatriz Colomina, Nuha Khoury and Helene Lipstadt in History, Theory, and Criticism. Appointed as Lecturers were: Daniel Greenwood in Architectural Design; Natalia Cardelino, Carl Rosenberg, and Barry Webb in Building Technology; Maura Coughlin, Edward Eigen, Leila Kinney and Stuart Steck in History,Theory, and Criticism; and Reiner Leist and Julia Scher in Visual Arts.

Spurred by the occasion of the Visiting Committee, students re-constituted a student organization, Architecture Student Council (ASC), with representatives from each level and discipline area. Students have long been represented on a number of department committees such as admissions and searches; to these were added appointees to Department Council, MArch Curriculum committee, and Studio Faculty committee. The ASC contributed agenda items to general departmental meetings.

Student Awards, Fellowships, Internships and Exchanges

Department or Institute Awards

The William Everett Chamberlain Prize for graduating BSAD for achievement in design (Octavio Gutierrez). The Sydney B. Karofsky '37 Prize for the outstanding Master of Architecture student with one further year of study (Laura Bouwman). The Francis Ward Chandler Prize for achievement in architectural design (Robert Brown). The Alpha Rho Chi Medal for leadership, service for the school and department, and promise of real professional merit (Rolando Mendoza). The AIA Certificate of Merit for second-ranked master of architecture student (Andrew Jonic). The AIA Medal for the top-ranked master of architecture student (Laurie Griffith). The S.M.Arch.S. Prize (Omar Khan, Marianne de Klerk, Asheshh Saheba). The Imre Halasz Thesis Award (Andrew Jonic). The AIA Foundation Scholarships (Pamela Campbell, Amanda Dickson). Faculty Design Award (Chris Berry, Annie Lo). Outstanding Undergraduate Prize (Molly Forr). Schlossman Research Fellow (Glaire Anderson, Amina Razvi). Ann Macy Beha Travel Award (Adam Griff, Rohit Mehndirhatta, Ruth Palmon, Matt Simitis). Louis C. Rosenberg Travel Award (Steven Jackson). Marvin E. Goody Prize (Lora Kim, Amina Razvi, Asheshh Saheba). Aga Khan Program Summer Travel Grant (Amina Razvi, Michele Lamprakos, Glaire Anderson, Cagla Hadimioglu). Robert Bradford Newman Medal for Merit in Architectural Acoustics (Jorge Carbonell, Mona Tamari). Skidmore, Owings and Merrill Foundation Traveling Fellowship Nominees (Talia Braude, Mark Jewell). Kristen Ellen Finnegan Memorial Award (Emily Gephart). Ralph Adams Cram Award (Garyfallia Katsavounidou '00). Marjorie Pierce/Dean William Emerson Fellowship (Pui Wan PeralTang). Hyzen Travel Fellowship (Katherine Wheeler-Borum, Erdem Erten, Janna Israel, Muhammed Muzaffar).

External Awards

Kress Travel Award (Juliana Maxim). Graham Foundation Grant (Juliana Maxim, with Associate Professor Mark Jarzombek). Wolfsonian Fellowship (Adnan Morshed). Wyeth Fellowship (Adnan Morshed). American Institute of Iranian Studies Fellowship (Talin der Grigorian). 2001 ASHRAE Homer Addams Award (Jelena Srebric '00). ASHRAE Grant-in-Aid Awards (John Zhai, Kazu Kobayashi). 4th International Laboratory in the History of Science Fellowhip (Janna Israel). Martin Family Society for Sustainability Membership (Brooke Wortham). Carter Manny Award/Graham Foundation honorary citation (Maha Yahya).

Internships

The department is pleased to host two competitive internships with firms of international renown and is presently negotiating for additional opportunities for outstanding students. This year Junko Nakagawa completed an internship at the Renzo Piano Building Workshop in Paris. Laura Bouwman was selected for a similar internship at RPBW again in Paris. Jason Hart was selected for the Takenaka Internship in Japan.

Exchange Programs
The department participates in several exchange or visiting student programs which select students by competition. TU Delft sent two students to MIT this year and in the coming year will receive two MIT undergraduate students (Tina Lin, John Rothenberg); University of Hong Kong sent one student; and Cambridge University, for the fourth year, sent two students.

More information about the Department of Architecture can be found online at http://architecture.mit.edu/.

Stanford Anderson

PROGRAM IN MEDIA ARTS AND SCIENCES

For the second year, the Program in Media Arts and Sciences (MAS) enrolled 24 students in its alternative freshman-year program. These students took special MAS recitation sections in two core freshman subjects, pursued Media Lab UROP research projects, and participated in two new MAS undergraduate subjects on graphic design and research methods. We view this program as a first step toward establishing a full-fledged undergraduate program in the future.

EDUCATION

For 2000–2001, the MAS program received 318 applications, a four percent increase over last year. From these, 46 new students (including 13 women) were offered admission: 38 for the master's program, and eight for the doctoral program. This brought the total MAS enrollment to 141, which included 37 women, two underrepresented minorities, and 56 foreign students. Of the total, 84 were master's candidates, and 57 were doctoral candidates. Thirty-four advanced degrees were awarded during the year (23 S.M. and 11 Ph.D.). The program offered 32 graduate subjects.

In addition, MAS faculty and research staff collectively advised and supported 42 graduate students from other MIT departments, including Electrical Engineering and Computer Science, Chemistry, Physics, Mechanical Engineering, Aeronautics and Astronautics, Materials Science and Engineering, Health Sciences and Technology Program, Technology and Policy Program, and the Sloan School of Management.

The largest undergraduate presence at the Media Laboratory continued to be UROP students, more than 250 of whom participated in research projects. Many of these undergraduates pursued their undergraduate theses under MAS faculty supervision. In addition, the Program in Media Arts and Sciences offered six undergraduate subjects, and five MAS faculty members and staff conducted freshman seminars or served as freshman advisors.

FACULTY AND STAFF

Isaac Chuang, who came to the MIT from IBM's Almaden Research Center in California, was appointed Associate Professor of Media Arts and Sciences. Dr. Chuang received his Ph.D. in electrical engineering from Stanford University. He was a postdoctoral fellow at the University of California before joining IBM in 1998. The recipient of numerous honors, he was named as one of the most promising Young Inventors by *Technology Review* Magazine in 1999. At the Media Lab he heads a new research group on *quanta*—the fundamental building blocks of physical media, information technology, and intelligence.

Bruce Blumberg, head of the Media Lab's Synthetic Characters group, was promoted to Associate Professor Without Tenure. He has been an Assistant Professor in the Program in Media Arts and Sciences since 1996.

Hiroshi Ishii, who has been an Associate Professor Without Tenure in the Program in Media Arts and Sciences, was promoted to Associate Professor with Tenure. He heads the Media Lab's Tangible Media group.

Two faculty members published new books:

- John Maeda, *Maeda @ Media* (Rizzoli (US), Thames Hudson (Europe) and Digitalogue (Japan), 2000); and
- Neil Gershenfeld, *The Physics of Information Technology*, (Cambridge University Press, UK, 2000)

FACULTY AWARDS

The Museum of Modern Art in New York mounted a special exhibition, *Workspheres*, to explore the role of design in our ever-changing work environment. It commissioned six design teams from around the world to present their concepts for new tools and environments for the workplace of tomorrow. One of those teams was headed by associate professor John Maeda, head of the Media Lab's Aesthetics and Computation group, and Joseph Paradiso, head of the lab's Responsive Environments group, in collaboration with Steelcase, Inc. Their contribution, entitled *Atmosphere*, is a multifaceted communication tool for navigating and organizing information.

Associate Professor Justine Cassell was one of two MIT faculty members honored with the 2001 Edgerton Award presented at the MIT Awards Convocation in May 2001.

Associate Professor Joseph Jacobson was one of nine winners of the 12th Annual Discover Awards.

Associate Professor John Maeda, Associate Director of the Media Laboratory and head of the Aesthetics and Computation group, was inducted into the Alliance Graphique Internationale, one of the world's most prestigious organizations for graphic designers. Professor Maeda also received the 2001 Design Management Institute Muriel Cooper Award.

Associate Professor Pattie Maes, head of the Software Agents group, was awarded the Lifetime Achievement Award by the Massachusetts Interactive Media Council.

Professor Marvin Minsky was awarded the Benjamin Franklin Medal by The Franklin Institute in Philadelphia, PA.

STUDENT AWARDS

The National Society of Black Engineers (NSBE) named Randall Pinkett as Graduate Student of the Year.

Brian Hubert, a doctoral graduate in mechanical engineering who worked with Professor Joseph Jacobson in the lab's Molecular Machines group won the seventh annual Lemelson Student Prize for innovation.

More information about the MAS program can be found online at http://www.media.mit.edu/mas/.

Stephen Benton

DEPARTMENT OF URBAN STUDIES AND PLANNING

A major event this year was reaccreditation of the Masters in City Planning (MCP) program. The final report of this rigorous process reaffirmed the Department of Urban Studies and Planning's (DUSP) position as the premier planning school in the U.S. The report gave high marks to excellent faculty leadership, an intellectually strong student body, a broad and diverse curriculum, exemplary student services and significant institutional support from MIT.

A top priority for 2000–2001 was to intensify our student recruitment effort. A new video highlights the incredible field opportunities available for students to work in collaboration with faculty on real-world planning problems. This unique tie between theoretical academic studies and field-based action research is one of the continuing allures of the program. Another critical component to the department's outreach efforts is a new initiative to reinvolve our alumni/ae in the life of the department. A series of open houses were held in U.S. cities to both recruit prospective students, as well as to reconnect with alumni/ae.

Space continues to have a big impact on the life of the department. While renovations are currently underway in Buildings 9 and 3, there is still a shortage of classroom and office space. We are anxiously awaiting the availability of space in Building 33.

CONTRIBUTION TO MIT-WIDE EFFORTS

The department launched plans for a series of annual joint studios with faculty and students from the University of Cambridge, as part of the Cambridge-MIT partnership (CMI). The first of these studios (to commence in fall 2001) will propose design strategies for accommodating growth pressures in Cambridge, England. The focus will be on seeking configurations of urban form and implementation mechanisms that will facilitate university/industry relationships and will enable enhanced creativity, innovation and productivity—while at the same time sustaining the extraordinary quality of Cambridge's environment. The studio is the initial joint activity committed to by CMI as a part of a much larger and longer collaboration, still under consideration by CMI, that creates a Joint Center for Urban and Regional Innovation.

At the request of the Provost, Bish Sanyal, Chair of the Department, joined a team of three senior faculty to visit Delft, The Netherlands last June and begin a discussion for a multi-year joint research effort. The department hosted a return visit by a number of Technical University of Delft (TUD) faculty in October, and participated actively in a joint teaching studio at TUD last January on the theme of "Open Design Methods." Later, DUSP participated actively in hosting a large delegation of faculty from TUD in May, and is currently deeply engaged in revising the first research proposal for the purpose of fund raising.

RESEARCH AND TEACHING ON URBAN PLANNING

The intellectual life of the department is organized largely around the activities of the five program groups, which reflect major areas of current planning practice: City Design and Development; Environmental Policy; Housing, Community and Economic Development; International Development and Regional Planning; and Planning Support Systems (Information Technology). Some highlights of the past year include the following:

During the fall of 2000, faculty and students from the City Design and Development (CDD) group conducted a studio investigating possible futures for the Southwest quadrant of Washington, D.C., in conjunction with the city's planning department (headed by a DUSP alum) and other neighborhood organizations. The studio posed alternatives for residential, commercial, and waterfront development, and attracted great attention from city officials and residents.

CDD students and faculty participated in two well-attended special colloquia held at MIT. The first, entitled "Metropolitanism in Practice," examined the benefits and pitfalls of strategies for cross-jurisdictional political, economic, and spatial integration at the scale of the metropolitan region. The second, "Urban Narratives: Making the City Speak," explored ways to activate the surface spaces freed up by the depression of Boston's Central Artery. CDD faculty conducted this workshop in conjunction with faculty from the Media Lab, New York designer Gregory Beck (an MIT alumnus), and the Boston Redevelopment Authority. The students' proposals have been featured in *Architectural Record* and on a sophisticated web site.

The results of the fall 1998 CDD colloquium and seminar on "Imaging the City" have recently been published as a book, edited by Professors Lawrence J. Vale and Sam Bass Warner Jr. The book examines one aspect of the legacy of MIT's Kevin Lynch, by exploring ways that city designers can shape urban images proactively.

The Environmental Policy Group (EPG) is currently conducting a series of comparative studies focusing on public policies that encourage sustainable development in various parts of the world. The Environmental Technology and Public Policy Program (within EPG), with support from the Dutch Government, completed the initial phase of a multi-year study on policies to facilitate environmental innovation and public entrepreneurship networks. The group also recently launched an environmental justice initiative that includes teaching, research, and capacity building activities. A new research project on Community Environmental Monitoring in the U.S. and across global supply chains was also begun this year.

EPG hosted a number of distinguished visitors during the year, including Professor Roland Scholz, Chair of Environmental Sciences, Swiss Federal Institute of Technology; Ernesto Cortes from the Industrial Areas Foundation, and Dr. Hillel Shuval, from the Hebrew University in Jerusalem. EPG offered a joint course with Professor Wim Hafkamp of Erasmus University on sustainable development. A number of EPG students spent Independent Activities Period (IAP) at the Technical University of Delft working on sustainability issues related to airport planning.

With a great deal of help from a number of graduate students, EPG has modified its curriculum—adding a series of methods modules and several courses dealing with environmental justice, brownfields redevelopment, environmental leadership, and industrial ecology. A new studio course in environmental planning was developed which funded a group of students to travel to Palawan Island, Philippines, to interact with agencies and non-governmental organizations (NGOs) working on ecological protection. Faculty in EPG also organized and hosted a number of conferences and workshops including the "Civic Environmentalism Roundtable" series which involved 10 leading scholars and four regional funders, and a "Regional Sustainable Development Forum" keynoted by Senator John Kerry and attended by over 300 participants.

The Housing, Community, and Economic Development (HCED) group continued to focus on how urban neighborhoods respond to the devolution of federal policy and the decreasing demand for low-skilled labor. Guest speakers focused on local efforts to deal with that devolution. This year, the group took on two additional issues: the role of community organizing in place- and faith-based organizations and the combination of physical and economic development in neighborhood commercial revitalization. The first of these resulted in a series of seminars in early April which featured Ernesto Cortes of the Industrial Areas Foundation and representatives from religious and nonprofit communities involved in organizing in Massachusetts. The second initiative involved the introduction of a studio course which provided assistance to the Boston Main Streets program in two neighborhoods. The course, taught by Senior Lecturer Karl Seidman, turned out to be a successful exercise in combining talents from HCED and the Design and Development program group and bodes well for future efforts to establish studios that cut across the program groups. Martin Luther King Visiting Professor J. Philip Thompson taught a course on urban politics and had a formative role in a departmental dialog on issues of race, class and gender. Recommendations from a report on these issues were subsequently incorporated into the department's long-range strategic plan.

The faculty in the International Development and Regional Planning (IDRP) group are involved in seven major multi-year research and teaching activities, each involving two to seven graduate students and/or SPURS (Special Program in Urban and Regional Studies) Fellows. For the group, one of the highlights of the year was the Zayed International Prize for the Environment, which is the largest environmental prize in the world, being awarded to the World Commission on Dams. Professor Balakrishnan Rajagopal, an IDRP faculty member, assisted in developing a legal and policy framework for assessing the social and ecological impact of large dams. He also worked with the United Nations Development Programme (UNDP) staff to operationalize human rights in the development process and to start an international research project on globalization and localization, focusing initially on South Asia. In addition, he helped established MIT's Program on Human Rights and Justice, as a collaborative effort between DUSP and the Center for International Studies. The program has organized several events including a speaker series, and aims to develop student internships and collaborative research projects with the United Nations and other agencies.

A second major highlight was the publication by Professor Alice Amsden of the book *The Rise of the Rest: Challenges to the West from Late Industrializing Economies* by Oxford University Press. A third important major activity is the conclusion of a World Bank-funded research effort by Professor Jennifer Davis in four South Asian case sites, to investigate the reform of public-sector water and sanitation agencies to boost responsiveness, accountability, and transparency in service delivery. The research team focused on innovative institutional approaches for infrastructure service delivery, including private-sector participation and community-management regimes.

A fourth group of faculty and students, led by Professor Judith Tendler, continues to work on issues of social investment, conducting various research projects in Northeast Brazil. This long-term research project combines

extensive field research by Ph.D. and MCP students with seminars held during the academic year related to the research.

Work by the fifth group is in the People's Republic of China (China) where a multidisciplinary team of chemical engineers, physicists, and planners from China, Japan, Switzerland, and the United States are working on energy conservation and pollution-reduction projects in the coke-making sector in Shanxi Province. As part of the Alliance for Global Sustainability, the next phase of the research, led by Professor Karen Polenske, will be to investigate the energy-efficiency at iron and steel complexes that are large users of coke in neighboring provinces. The team is making a video for use as part of a web-based book on the project.

A sixth group, led by Visiting Lecturer Anna Hardman, is working on the impacts of rent decontrol on housing markets in Egypt. A seventh group is studying the increase of mobility and motorization in developing countries. This phenomenon poses a serious threat to environmental, social, and economic conditions especially in major cities. Many of the research efforts by the IDRP group focus on comparative studies between industrialized and developing countries. Overall, the faculty and students are working or planning to work on all continents, with the latest planned activity being a collaborative project with Boston University on water in African cities. This initiative engages a series of inter-related questions regarding the changing form and function of African cities; the variety of institutions and communities found therein; and the relationship of these entities to water and waste. In each case, we will bring expertise in both urban and regional planning (MIT) and interdisciplinary social sciences (BU) to bear in collaborative investigations of these complex issues.

Recent advances in information technologies have enabled the location and spatial interaction of people, buildings, and events to be tracked, modeled, visualized, and manipulated as never before. The result has been an explosion of new opportunities—and risks—ranging from new "location based" services, e-government experiments, environmental monitoring, and urban simulation models to privacy concerns, micro-redlining accusations, and digital divide questions. The Planning Support Systems (PSS) group has continued its innovative research and educational activities on many of these issues. New support from the Open GIS Consortium and the Federal Geographic Data Committee has expanded the group's work on the interoperable Geographic Information Systems (GIS). These next-generation GIS tools and standards provide the interoperability and modularity that metropolitan agencies and NGOs need to coordinate programs and share spatially referenced data effectively. Collaborative research with the Department of Civil and Environmental Engineering and the Center for Transportation Studies has also expanded to include IT-related transportation planning work with the Chicago Transit Authority as well as with Puerto Rico's new "Tren Urbano." PSS work on community networking and electronic neighborhoods has also expanded with the addition of Professor Keith Hampton to the faculty this spring. Other active research areas include modeling urban "respiration" (how land-use planning can affect metropolitan air pollution patterns), welfare-to-work accessibility, land use and transportation interactions, urban design assistance, political redistricting, and representation aides for environmental impact assessment and collaborative planning. Each of these areas has involved class projects and thesis work with "real world" partners and impacts involving several federal, state, regional, and local agencies and NGOs. Several of these agencies and organizations have hired recent graduates. Other graduates have undertaken a variety of positions ranging from a postdoc at Harvard and a faculty appointment in Texas to founding a "startup" that is an "application service provider" of mapping services for municipal agencies.

GRADUATE DEGREE PROGRAM ENROLLMENT AND ACTIVITIES

Our graduate programs enrolled 195 students this year. Of the total, 55 percent were women, nine percent were students of color, and 28 percent were international students. The department granted 45 MCP, four S.M., and five Ph.D. degrees. The department aims to increase the percentage of minority enrollment to 25 percent.

Faculty continued to offer a wide array of for-credit offerings during the Professional Development Institute held in the Independent Activities Period (IAP). In addition to Introduction to Computers in Public Management II—required of all first-year Master's students—seven additional for-credit courses were offered this year: Management Fundamentals for Leaders in Non-Profit Organizations; Designing Access to Leadership Development; Digital Storytelling and Community Building; Environmental Planning Workshop: Risk Analysis and Management; Inner City Revitalization: An Alternative Smart Growth Strategy; Bridging Racial and Cultural Differences; and, Neighborhoods and Networks. These classes, combined with non-credit offerings, attracted both undergraduate and graduate students from across the Institute, alumni/ae and local professionals.

The Master's in City Planning (MCP) Committee devoted much of its time this year to revitalizing the core curriculum of the Masters in City Planning program. This is the flagship academic program of our department that was last revised over a decade ago. The major thrust of the new curriculum is to reassert the common values and practices that bind together the different areas of specialization within the department and the profession. Within

recent years, these areas have become increasingly independent, threatening our focus on the core mission of city planning.

The new curriculum will also strengthen our connection to the profession, by ensuring that all students have experience in the practice of city planning—synthesizing solutions to urban problems in the field. Specific elements of the new curriculum that have been adopted by the faculty include:

- A new "Gateway" subject on the cross-cutting issues of planning and political economics that all students will be required to take;
- A requirement that all specialization areas offer an introductory subject accessible to all students (The aim is to increase understanding of the specializations and to encourage students to learn about more than one.);
- Integration of computing skills into the content of core subjects rather than offering separate computer classes. (New or revised subjects will include: quantitative reasoning and computing; communications and computing; research methods and computing.); and
- A requirement that all MCP graduates participate in a practicum workshop that challenges them to synthesize planning solutions for communities and clients in the field.

Subcommittees are now working to operationalize these changes, which will be put in place by the fall of 2002.

Financial aid for master's students continues to be a critical issue. We have committed to graduate fellowships the full $225,000 in Pool A funding which we received from the Institute. This has made a big impact on our ability to attract the best students and our admissions yield was significantly higher this year than in past years. The problem is still not completely solved and we continue to raise funds to launch a special fund for those graduates going on to low-paying careers in public service.

The Ph.D. Committee addressed a number of issues during the year, including methodological course requirement, shifting the timing and content of the first-year methods course, and the process by which Ph.D. students are admitted. Further work on these issues will continue next year.

UNDERGRADUATE PROGRAM ACTIVITIES

During 2000–2001, the Undergraduate Committee continued to focus on developing the community of undergraduate majors and integrating them into department-wide activities. The committee continues to focus its attention to the design and maintenance of the undergraduate curriculum and its three tracks: Urban and Environmental Planning, Urban Studies, and Urban and Regional Public Policy. As a result of this restructuring, several new undergraduate subjects were created in the 2000–2001 academic year.

Continuing the success of earlier study trips to Montreal, London, and Barcelona, the department continued its commitment to offering an annual study trip for undergraduate majors. During IAP 2001, Professor Robert Fogelson led a study trip to Venice, Italy in which eight majors participated. The trip was preceded by a fall seminar introducing planning and development issues in Venice.

The interdisciplinary Minor in Public Policy, a program for which we share responsibility with our colleagues in the Department of Political Science, is now in its second year of operation.

Our undergraduates continue to be involved in a wide variety of community-based activities, most notably planning for new on-campus housing. The department has made a commitment to assisting these outside activities of our students in whatever way possible.

In the fall of 1999, the department welcomed to its faculty Dr. Eric Klopfer, the new director of the Teacher Education Program (TEP). Through the TEP, MIT undergraduates can complete certification in secondary math and science teaching. While the number of students currently certified by the TEP is relatively small, it does certify teachers in high-need areas such as physics and mathematics. The unique approach that the TEP takes to teacher education is looked to as a model by the American Association of Universities and other institutions nationwide.

Over the last year the TEP has strengthened its relationship with the Cambridge Public Schools through collaborative projects. At the same time, it has initiated new relationships with the Boston Public Schools, especially Boston High School. Dr. Klopfer has also hosted summer institutes on educational technology for Boston area teachers in conjunction with the TEP.

For more information on the TEP see http://education.mit.edu/.

STUDENT AWARDS

Our graduate and undergraduate students received many awards from national and international organizations, the Institute, and the department.

At its annual Commencement Breakfast, the department awarded the following: The American Institute of Certified Planners, Outstanding Student Award was presented to Master's in City Planning (MCP) student Jennifer James of Schenectady, NY. The Departmental Service Award was given to MCP students Tunua Thrash of Los Angeles, CA and Ana Lasso of Huntington Park, CA. Natasha Freidus of New York, NY received the prize for Outstanding MCP Thesis, and Shanna Wasserman of Anchorage, AK received an Honorable Mention. The Outstanding Undergraduate Thesis/Project award went to Yanni Tsipis of Boston, MA, with an Honorable Mention to Stefani Okasaki of Kensington, CA. The Wallace, Floyd Award for City Design went to to first-year MCP student Alexis Bennett of Venice, CA and the Flora Crockett Stephenson Writing Prize was presented to Ambika Prokop of Sunnyvale, CA. Support staff of the department who were honored included S. Holly Kosisky for Outstanding Contribution to the Intellectual Life of the Department and Janice O'Brien for Outstanding Service by Support Staff. A Special Departmental Citation went to Duncan Kincaid.

During the past year, DUSP students have won the following awards: Ph.D. student Raquel Gomes of Potomac, MD received an Industrial Performance Center Doctoral Fellowship. Mellon-MIT Program on NGOs and Forced Migration Research Grants went to MCP students Shahid Punjani of Vancouver, Canada and Katrina Simon of Stone Mountain, GA, and Ph.D. student Smita Srinivas of Bangalore, India. MCP student Bilal Zia of Pakistan won a Carroll Wilson Award, and a Kelly Travelling Fellowship was awarded to undergraduate Sandy Pae of New York, NY. MCP student Tunua Thrash of Los Angeles, CA received the Umoja "Unity" Leadership Award from the Graduate Student Office. Ming Zhang of Wuhan, China won a UPS Doctoral Dissertation Fellowship from the MIT Center for Transportation Studies and Monica Pinhanez of Sao Paulo, Brazil received a Center for International Studies Doctoral Research Fellowship. Jonna Anderson of Vancouver, WA was inducted into the MIT Chapter of Phi Beta Kappa. Jovonne Bickerstaff of Akron, OH won a Peter J. Eloranta Summer Undergraduate Research Fellowship, and Sara Jo Elice of Scarsdale, NY received the Dean A. Horn Award.

Students won the following awards from outside of MIT: Senior Stefani Okasaki of Kensington, CA won a Henry Martinelli Fellowship. MCP student Adam Varat of Pacific Palisades, CA was selected for the EDAW Summer Student Program. Carol Tucker, MCP student from Westford, MA won a Switzer Environmental Fellowship and Tami Chuang, MCP student from Palo Alto, CA was a Second Place Winner in the Federal Home Loan Bank of Boston and Citizen's Housing and Planning Association's Affordable Housing Competition. George Proakis of Boston, MA received a Community Service Award from the Fenway Community Development Corporation. Cybele Chang of Glencoe, Illinos was awarded an American Association of University Women and a Switzer Environmental Fellowship.

MCP student Apiwat Ratanawaraha of Bangkok, Thailand won a Harvard-Yenching Scholarship; Jennifer James of Schnectady, NY received a Rappaport Foundation Fellowship; and Tunua Thrash of Los Angeles, CA was named an Emerging Leader by the National Congress of Community and Economic Development. Ph.D. students Genevieve Connors of New York, NY and Celina Su of East Brunswick, NJ received Honorable Mention from the NSF Graduate Fellowship Research Program. Ming Zhang of Wuhan, China was awarded a Lincoln Institute of Land Policy Dissertation Fellowship. Monica Pinhanez of Sao Paulo, Brazil won an International Labor Organization Phelan Fellowship, and Pierre Fallavier of Boulogne Billancourt, France received both a Fulbright Fellowship and a Cercle Universitaire Franco-Americain Travel Grant.

Department of Housing and Urban Development Fellows for this year included MCP students Tunua Thrash of Los Angeles, CA; George Samuels of Harlem, NY; Manuel Martinez of Roxbury, MA; Jesse Williamson of Berkeley, CA; Antonio Gonzalez of San Francisco, CA; and Marisa Gaither of Los Angeles, CA. Woodrow Wilson/Public Policy and International Affairs Fellows were MCP students Tunua Thrash of Los Angeles, CA; Katrina Simon of Stone Mountain, GA; Diana Auburg of Cambridge, MA; and James Wilson of Los Angeles, CA.

ALUMNI/AE NEWS

Local alumni/ae continued to play an active role in sponsoring internships for students, providing career advice at the alumni/ae career forums organized by each of the department's program groups and participating as guest lecturers in numerous classes. An urban design studio course looked at some of the planning challenges facing DUSP alumnus Andrew Altman, Director of Planning for the District of Columbia. DC-area alumni/ae were invited to the class presentations to the community. More than a dozen alumni/ae from across the country joined Chancellor Phil Clay, Department Chair Bish Sanyal, and other DUSP faculty at the first meeting of the DUSP Alumni/ae National Advisory Board. This day-long session was held in October to set the agenda for the new alumni/ae relations initiative launched in collaboration with the MIT Alumni/ae Association. Many local alumni/ae joined this

group at a reception featuring a talk by new faculty member Professor Anne Whiston Spirn. DUSP alumni/ae again made a significant contribution at the DUSP Open House in New York City in the fall. A monthly electronic newsletter has been added to the print publications we use to keep in touch with our alumni/ae. The spring DUSP/TPP (Technology and Policy Program) Career Day again drew a good number of DUSP alumni/ae to the campus to acquaint current students with their organizations and recruit for current openings. Departmental receptions held at the annual conferences of the American Planning Association and Association of Collegiate Schools of Planning provided venues to catch up with alumni/ae from across the country.

FACULTY ACHIEVEMENTS

The award for Best Book in Urban Affairs published in 1999 or 2000 from the Urban Affairs Association was given to Professor and Associate Department Head Lawrence Vale for *From the Puritans to the Projects: Public Housing and Public Neighbors*. Professor Frank Levy was a Visiting Scholar at the Russell Sage Foundation and the Rockefeller Study Center in Bellagio, Italy. Professor Ceasar McDowell won a Rockefeller Foundation Fellowship in Residence in Bellagio, Italy.

The department hosted two Martin Luther King Visiting Professors: Raul Lejano and J. Philip Thompson, both of whom will be returning next year. Two new faculty members will be joining the department next year. Professor Diane Davis specializes in the politics of urban policy, urban history, cities and national development and policing and public security. Her addition to the faculty brings the number of senior tenured women faculty up to five. Professor Lorlene Hoyt focuses on municipal geographic information systems, business improvement districts, and public service systems.

Faculty departures this year included Aixa Cintron, Qing Shen, Mike Shiffer, and Paul Smoke—all of whom left for tenured positions at other universities. The department conducted a search in the spring to replace Professor Cintron with a minority faculty member. An offer was made to a candidate, but was not accepted. The department has hired a search firm to begin a new search next year.

INTERNATIONAL CONNECTION

The Special Program for Urban and Regional Studies (SPURS) hosted eleven fellows from Brazil, China, Ecuador, India, Korea, Nigeria, Russian Federation, Taiwan, and Venezuela. Three of this year's fellows were from last year's group who continued on to earn the M.S. SPURS degree. The work of the fellows embraced several fields, including environmental and regional planning, urban design, sustainable development, regional industrialization, community affairs, and transportation infrastructure. In January, the fellows organized a seminar entitled "Global Forces and Local Spaces." Each SPURS Fellow made a presentation of his/her work. The presentations were followed by discussion generated by two invited guests who are experts in the fields of architecture and public policy. This year's traditional SPURS Luncheon Seminars, where distinguished speakers from cross-disciplinary areas came to share their research and experiences, were held on Mondays. The fellows also had regular Wednesday evening meetings where each fellow presented their research project and received feedback from their peers. The fellows have also organized several professional trips to Washington, DC, New York City, and Chicago. While in these cities, they had the opportunity to visit with professionals from the World Bank, United Nations Development Programme (UNDP), other international organizations such as the Inter-American Development Bank, non-profit organizations, and professional organizations such as the American Institute of Architects. The purposes of these meetings varied, from learning about the organization, to obtaining information for their research projects, to networking for future job opportunities.

COMMUNITY OUTREACH

The Center for Reflective Community Practice (CRCP) continued into its second year by launching the newest version of its national community fellows program, the Reflective Practitioner Fellowship. Fourteen fellows from 12 communities attended two retreats and two intensive residency periods to acquire reflective practices and use them for expanding their thinking about their work. In addition, the center sponsored an ongoing Community Scholar in Springfield, MA, who continued to develop and build capacity for a CRCP partnership with her community. As a result, Springfield will officially be the center's first community partner starting fall 2001. The center's first Research Fellow developed a research and evaluation capacity aimed at documenting the tools, outcomes, and processes of the reflective practice methodology offered to communities and community leaders.

In January, the center conducted two IAP courses that brought its approach to community, technology, and reflective practice to MIT students and affiliates. One course was a design studio aimed at developing a web site for an online leadership learning community. The other taught digital storytelling technology as a tool for community building and reflection on diversity issues. CRCP also offered its first community digital storytelling workshop to residents and leaders in Springfield, MA. The center sponsored several symposia related to community and reflective practice.

The center continued its work toward making information technology broadly accessible. Its flagship project in this area, connecting all the residents in a Boston housing complex to the Internet and assisting them in creating their own information system, marked the opening of the community computer center and the installation of cutting edge computer and communications equipment.

Starting this year a new area of work for the center was R&D partnerships with foundations that sponsor community-building work. CRCP is working with these foundations to design processes for learning and reflection from and by their grantees. This represents an additional level in the field of social justice and community work to introduce reflective practice as a means of creating new thinking, questioning assumptions, and heightening learning capacity in individual practitioners, community groups, and the foundations who sponsor community initiatives.

In 2001–2002, the center will be working aggressively to develop its work with two community groups in Springfield, to design and run a studio course for DUSP students to do R&D projects for the Springfield groups, and to develop further methodologies for carrying out and capturing reflective practices. Details of all of the CRCP activities are available on its web site at http://web.mit.edu/crcp/.

RESEARCH FUNDING

Faculty raised $360,500 in new funds for the following projects.

Professor Dara O'Rourke was awarded a grant for $115,500 out of a total of $1 million from the William and Flora Hewlett Foundation for the "Project on Public Problem Solving." It will be completed over three years in collaboration with the Kennedy School of Government at Harvard and Columbia University Law School. The research project will study and develop theoretical accounts of new forms of public sector problem solving involving direct deliberation, pooling of knowledge on local innovations, and centralized monitoring and accountability around environmental and educational problems.

Research Scientist Tom Piper received $100,000 from State Street Bank to organize "After the Big Dig: A Boston Conference on the Future Land Above the Central Artery."

Professor Joseph Ferreira raised $55,000 from the U.S. Department of the Interior's Federal Geographic Data Committee that is charged with enabling a National Spatial Data Infrastructure. The project expands previous work on MITOrthoTools to facilitate web-based access to orthophoto imagery (corrected aerial photos).

For the sixth funding cycle, the department received $90,000 from the federal Department of Housing and Urban Development to support minority and economically disadvantaged graduate students.

More information about the department can be found on the newly redesigned web site at http://dusp.mit.edu/.

Bish Sanyal

CENTER FOR ADVANCED VISUAL STUDIES

The Center for Advanced Visual Studies (CAVS) is an art-based laboratory for collaborations between artists, scientists, and technologists. These collaborations are typically built around projects undertaken by resident fellows, who also conduct seminars and supervise student participation. An emerging mission of the CAVS is the exploration of the digital arts as a common ground for collaborative projects. Our goal is the creation of important art that could not or would not be possible except at MIT.

ACTIVITIES OF FELLOWS AND AFFILIATED FACULTY

Fellow Hisham Bizri's film *City of Brass* was selected for screening at the Museum of Modern Art and the Milan International Film Festival. With seven of his students, he was invited to FIPA, an audio-visual festival in Biarritz, France, where they created a piece entitled *Scent.*

Visiting Fellow Kelly Heaton won the 2001 L'Oreal Prize in the Art and Science of Color, for her MIT thesis project "Physical Pixels." She was also one of ten New England artists selected to participate in the 2001 Annual Exhibition at the DeCordova Museum, presenting her installation entitled "Reflection Loop."

Fellows Elizabeth Goldring and Seth Riskin received a grant from the MIT Council for the Arts in support of a video production of their "Eye Dance" collaborative piece. Seth Riskin performed "Eye Dance" in five venues during the year, and was also named an artist-in-residence at the Center for Holographic Arts, NY, NY.

Director Emeritus Otto Piene was honored with a retrospective exhibition at the new 24-Hour-Kuntsmuseum in Celle, Germany. At CAVS, he is organizing center documentation for 1968 to 1994, and making preparations for a Sky Art Conference in 2002.

Educational Activities:

Glorianna Davenport and Steve Benton conducted a weekly seminar series in the CAVS conference space. The subject, entitled MAS.878 Experiences in Interactive Expression, brought the artists Ken Goldberg, Jack Ox, Christa Sommerer, Tetsuro Fukuhara, and Christian Boustiani to MIT for a day of discussions with students and faculty. At the end of the fall semester, an exhibition of student-produced interactive installations was presented at CAVS.

Stephen Pieper, Bruce Blumberg, Glorianna Davenport, and Steve Benton introduced a new course, MAS.877: Special Effects for New Cinema, for the spring term. Guest lectures by art-science-technology researchers enriched a curriculum of digital image processing techniques and projects.

Fellow Hisham Bizri conducted a new weekly seminar, MAS.879 Narrative and Central Conflict Theory, with undergraduate and graduate students.

A total of eight MIT students joined the CAVS as UROPs during this year.

PERSONNEL

The Japanese artist Naoko Tosa was a Visiting Professor for half of the year, and plans to return next year as a Fellow. Kelly B. Heaton joined us as a Visiting Fellow for the year. Hisham Bizri continued in his second year as a Fellow.

More information about the CAVS can be found online at http://cavs.mit.edu/.

S. A. Benton

AGA KHAN PROGRAM FOR ISLAMIC ARCHITECTURE

The Aga Khan Program for Islamic Architecture at Harvard University and the Massachusetts Institute of Technology (AKPIA) was established in 1979 through a generous endowment from His Highness The Aga Khan. AKPIA is dedicated to the study of Islamic architecture and urbanism, visual arts, and conservation and rehabilitation in an effort to respond to the cultural and educational needs of a diverse Islamic world. Our mission is to improve the teaching of Islamic art and architecture, promote excellence in professional research, and enhance the understanding of Islamic architecture and urbanism in light of contemporary critical, theoretical, and developmental issues. AKPIA also promotes the visibility of pan-Islamic architectural, artistic, and cultural heritage.

Endowments at Harvard University and MIT support parallel AKPIA professorships, doctoral scholarships, and library and archive collections. Funding, in the form of annual Aga Khan Trust for Culture (AKTC) grants, supports graduate degree study, research, administrative and outreach activities. Since the program's inception one hundred and twenty-six graduates have been awarded Doctoral or Master's degrees in the study of Islamic art and architecture. Today's current graduate student population numbers twenty-eight advanced degree candidates.

Harvard Aga Khan Professor Gülru Necipoglu and MIT Aga Khan Professor Nasser Rabbat direct the academic and research programming of their respective institutions. They oversee AKPIA's research and publications, organize annual lecture series and conferences, and sponsor visiting scholars and professors throughout the academic calendar year. Other AKPIA professorships include a junior professorship at MIT and the recently endowed Aga Khan Professorship of Landscape Architecture and Urbanism in Islamic Societies at the Harvard University Graduate School of Design.

A recent addition to our donor's educational and cultural mission has been the AKTC's sponsorship of ArchNet. A flagship web site project being developed by the MIT School of Architecture in collaboration with MIT Press, ArchNet fosters an online community of architects, planners, urban designers, landscape architects, and scholars researching the Islamic world. The site promotes the communication and sharing of resources among international scholars and professionals. Currently, more than 1,700 online subscribers from over 65 countries are accessing ArchNet's resources and virtual workspaces.

The following summarizes the academic and research activities of the MIT Aga Khan Program for Islamic Architecture.

STUDENTS

Five S.M.Arch.S. students were enrolled in the S.M.Arch.S. program under the sponsorship of AKPIA. Two candidates completed their degree requirements and graduated: Yasmine Abbas and Bianca Nardella. The three continuing candidates are: Imdat As, Cagla Hadimioglu, and Jateen Lad. MIT Aga Khan Professor Nasser Rabbat is supervising the above theses. He also supervised the theses of Shundana Yusaf and Marianne de Klerk, who won the MIT Spring 2000 best thesis award.

Doctoral students sponsored by AKPIA in the History, Theory and Criticism Program are: Maha Yahya, Lara Tohme, Panayiota Pyla, Talin Der-Grigorian, Glaire D. Anderson, and newly admitted Ph.D. student Michele Lamprakos.

AKPIA student Iffet Orbay defended her thesis in December 2000 and the following students continue work toward their degrees: Maha Yahya, Lara Tohme, Panayiota Pyla, Talin Der-Grigorian, Glaire D. Anderson and Michele Lamprakos.

Ph.D. theses supervised by Professor Nasser Rabbat are: Lara Tohme, Stacy Holden, Stephen Wolf and Zayde Antrim.

AKPIA/MIT AKPIA 2001–2002 Travel Grants were awarded to Michele Lamprakos HTC Ph.D., Glaire D. Anderson HTC Ph.D., Amina Razvi M.Arch. and Cagla Hadimioglu S.M.Arch.S.

Lectures
Aga Khan Professor Nasser Rabbat organized the fall 2000 and spring 2001 MIT/AKPIA "An Evening With Lecture Series." Fall 2000 lecturers were: Dr. Sabine Kraft, Architect, Ludwig Althaus Firm, Marburg-Michelbach, Germany; Professor Miki Desai, School of Architecture, Centre for Environment Planning and Technology, Ahmedabad, India; Professor Yasser Tabbaa, University of Michigan, Ann Arbor; and Professor Renata Holod, History of Art Department, University of Pennsylvania.

Spring 2001 lecturers were: Dr. Abidin Kusno, Metropolitan Studies Program, New York University; Dr. Ruba Kana'an, Barakat Trust Fellow in Islamic Art and Archeology Oriental Institute, Oxford, UK; Dr. Heghnar Watenpaugh, Department of Art and History, Rice University; Dr. William J. Glover, Department of Architecture, University of Michigan, Ann Arbor; Dr. Kishwar Rizvi, Post-Graduate Fellow, Yale University; Professor Machiel Kiel, Harvard Aga Khan Visiting Scholar and Professor, University of Utrecht, The Netherlands; Dr. Shirine Hamadeh, NEH/ARIT Post-Doctoral Fellowship, American Research Institute in Turkey; and Dr. Howayda Al-Harithy, Dept. of Architecture and Design, American University of Beirut.

AKPIA students presented research during the spring 2001 semester. AKPIA HTC Ph.D. candidate Panayiota I Pyla presented her work carried out in Syria and Greece on the environmental concepts in the works of C.A. Doxiadis and Hasan Fathy. AKPIA Summer 2000 Travel Grantees presented their research in April: Bianca Maria Nardella, "Traveling the Balkans"; Yasmine Abbas, "Mostar, Ville Ecorchée"; Marianne de Klerk, "Historicizing the Landscape: Recovering the Aesthetics of the Alhambra."

In February, AKPIA sponsored, with MIT/HTC and the Women's Studies Program/Anthropology, a lecture by Miriam Cooke, "The Political Aesthetics of Destruction: Re-representing Beirut 1975–1995."

CONFERENCES
AKPIA organized the May symposium, "Exploring the Frontiers of Islamic Art and Architecture." The two-day event was well attended. The symposium explored artistic and architectural transformations on the Islamic frontiers: territorial, conceptual, and cultural.

Opening remarks were presented by Architecture Department Head Stanford Anderson and MIT/AKPIA Professor Nasser Rabbat. Speakers included: Oleg Grabar, Princeton and Harvard University; Nasser Rabbat, MIT; Finbarr Barry Flood, National Gallery of Art; Michael W. Meister, University of Pennsylvania; Priscilla Soucek, New York University; Cynthia Robinson, University of New Mexico; and Jamal Elias.

FACULTY RESEARCH AND TEACHING ACTIVITIES
Professor Nasser Rabbat, Aga Khan Professor of Islamic Architecture, taught "Issues of Medieval Islamic Urbanism" in the spring 2001 semester. This course focuses on the city as a major element in the understanding of Islamic history.

In addition to teaching, Professor Rabbat served on the following committees at MIT: Academic Director, ArchNet; Director, Aga Khan Program; Chair, Aga Khan Travel Grants Committee; Convenor, "An Evening With," lecture series; Chair, Aga Khan Career Development Professor Search Committee; Member, HTC Admissions Committee; and Member, Committee on Faculty Administration. He also served as a Member of the Aga Khan Landscape Design Professor Search Committee at the Graduate School of Design, Harvard University.

Professor Rabbat continues to publish prolifically in journals and books as well as in Arabic newspapers. His publications include "Maqrizi's *Khitat:* An Egyptian *Lieu de Mémoire"* in *The Cairo Heritage.Papers in Honor of Layla Ali Ibrahim,* ed. Doris Behrens-Abouseif (Cairo, AUC Press, 2001), 17–30; "Islamic Architecture: Trying to Break out of the Old Paradigm," (in Arabic) *Majallat al-Funun* 1 (January 2001): 39–41; "Architecture and Memory: An Invitation to Think," (in Arabic) *Wughat Nazar* 23 (December 2000): 62–64; "Representing the Mamluks in Mamluk Historical Writing," in *The Historiography of Islamic Egypt, c. 950–1800,* Hugh Kennedy, ed. (Leiden, E. J. Brill, 2000), 59–75; "Remarks on the Document, *Memory and Reconciliation: The Church and the Faults of the Past,* Did the Pope Apologize to the Muslims?" (in Arabic) *Wughat Nazar* 18 (July 2000): 46–49; "Adonis, l'homme critique et poète d'un même souffle," in *Adonis, un poète dans le monde d'aujourd'hui, 1950–2000* (Paris: Institut du Monde Arabe, 2000), 314–16 and "Restoration Projects in Islamic Cairo Critiqued," in *Medina* 13 (May-June 2000): 48–51.

In May 2001 Professor Rabbat participated in the seminar "Islam and Urban Culture in Egypt" organized by the Oxford Centre for Islamic Studies (OCIS) and the Centre for Islamic Art and Archaeology in Oxford (CIAAO), Oxford, England, on the topic "History, the City, and Criticism: Maqrizi and his Book on the Khitat." April 2001 he participated in Conversation on the Future of the Humanities in American Universities, American Council of Learned Societies (ACLS in New York and he was co-organizer and discussant for "Architectural Education Today," The 8th Architecture and Behavior Colloquium in Monte Verita, Ascona, Switzerland. During the past year he also gave lectures to graduate students on the Islamic City at the School of History, University of Fez SAIS, and on Maqrizi and the writing on urban history in the Arabic/Islamic tradition at the School of History, University Muhammad V, Rabat, in Morocco.

Dr. Nuha Khoury, Visiting Assistant Professor in the fall of 2000, taught "Religious Architecture in Islamic Cultures". Professor Khoury received her Ph.D. at Harvard in 1992, and currently teaches at the University of California at Santa Barbara.

Dr. Jerrilyn Dodds, Visiting Associate Professor in the spring of 2001, is Professor of Architectural History and Theory at the School of Architecture of the City College of the City University of New York. Her work centers on issues of artistic interchange and identity, and the problems surrounding art and minorities in pluralistic societies. She has worked extensively in Spain, Bosnia and New York City and is known as a distinguished author, curator and filmmaker.

Visiting Professor Hasan-Uddin Khan taught in the spring of 2001 "Conservation—Extreme Architectural Conservation in the Face of Globalization, War and Tourism." The seminar examined international contemporary practices of restoration, conservation and reuse with special reference to extreme situations where the globalization process suppresses architectural and community identity. Loss factors brought about by conflict, war, and tourism were examined. The course sought to understand, and illustrate through case studies the principles and directions of conservation efforts.

LIBRARY RESOURCES

The AKPIA Rotch Library and Visual collections continue to review the visual teaching collections, and through collection development enrich the visual archives. Books and visual materials collection development included works of all periods on Islamic cities, studies of conservation and preservation, and modern critical editions of older works on architecture and urbanism in the Muslim world. For the visual collections a critical review of major areas in the teaching collections was undertaken to upgrade older materials and add to specific areas of Cairo, Jerusalem, and other major historic cities. Additions to the visual archives included several collections covering sites in Iran, Singapore and India. The Islamic Architecture web page continues to evolve and serves as a teaching and reference resource by universities throughout North America and Europe.

The School of Architecture, American University of Sharjah, UAE invited Omar Khalidi to lecture and show an exhibition on Designed Mosques of North America. At the request of the U.S. Department of State he also spoke to an audience at the University of Bahrain's School of Architecture and Planning and at the School of Arts in Doha, Qatar. With Visual Collections Archivist, Ahmed Nabal, he attended the Fall 2000 Middle East Librarians Association annual meeting in Orlando. In the fall of 2000 Khalidi visited Dhaka for a seminar on Architecture and Tourism and the International Book Fair and served as a discussant on innovation in mosque design panel in Kashan.

AKPIA CENTRAL OFFICE REPORT

The Central Office provided organizational support to MIT Aga Khan Professor Nasser Rabbat and visiting professors Nuha Khoury, Jerrilyn Dodds, and Hasan Khan. Further support was made available to invited lecturers, students, and visiting colleagues.

Throughout late-summer 2000, the Central Office donated comprehensive monograph collections of AKPIA and AKPIA-related publications from its archives to the ArchNet project. Sequential volumes of *Muqarnas*, *Mimar*, AKPIA research monographs, newsletters, and Annual Reports were unbound for digital scanning. Projects were also underway to retrospectively document AKPIA publications, published theses, lectures, awards, and alumni records. The information was compiled electronically. A comprehensive joint-program alumni and current degree student survey was submitted to the MIT Aga Khan Professor in April.

Two meetings of the AKPIA Executive Committee took place during the fall 2000 semester to discuss governance and planning issues. New members joining the Executive Committee were Harvard Dean Peter Ellison, succeeding former Dean Wolff and Harvard Professor Wheeler Thackston who assumed the seat vacated by Harvard Professor Susan Miller.

AKPIA supported the MIT Graduate Student Council Turkish classical music performance by Cambridge Musiki Cemiyeti in November. The AKPIA Assistant to the Director assisted fundraising efforts for *Interpolations: New Housing Designs for Post-War Bosnia-Herzegovina.* A three-year project development funded from outside foundations, teams from MIT School of Architecture, the University of Sarajevo and Yildiz Technical University participated throughout the academic year in a remote-site design collaboration. Participants met for final project reviews at MIT in May 2001.

The past year's AKPIA staffing comprised the full-time Assistant to the Director, Alberto Balestrieri, our half-time Administrative Assistant Robert Marlatt and a new half-time Senior Office Assistant, Jose Luis Arguello, who replaced Michelle Woodward who left in the fall of 2000 to pursue MIT graduate studies.

Nasser Rabbat

CENTER FOR REAL ESTATE

The Center for Real Estate (MIT/CRE) was founded in 1984. The mission of the center is to improve the quality of the built environment through education and research and by facilitating communication among members of the real estate industry worldwide. To this end, it carries out research and teaching programs in the field of real estate development, investment, and management. It also provides a forum for the exchange of information and the discussion of issues by real estate professionals from around the world. The center's principal activities include an 11-month professional degree program leading to a Master of Science in Real Estate Development and a research agenda of issues relating to the planning, development and management of real estate, including its financial performance.

EDUCATION

Thirty-four members of the Class of 2000, the sixteenth class of MSRED graduates, received their S.M. degrees in Real Estate Development in September 2000. Three more students completed their requirements and received their degrees in either February or June of 2001. The 30 members of the incoming Class of 2002, which includes seven joint degree candidates, were selected in April from an applicant pool which was strong though smaller than last year's. The new class of 13 women and 17 men includes 11 international students. Five incoming students already hold advanced degrees in business, architecture, finance, or law.

The center is fully supporting one ongoing Ph.D. candidate jointly in the Departments of Economics and Urban Studies and Planning.

There were no major changes to core courses this year, though course content continues to evolve as the real estate industry changes, particularly in the area of finance and real estate capital markets. Next year, while Timothy J. Riddiough, Associate Professor in the Department of Urban Studies and Planning, is on sabbatical, his core courses 11.431J Real Estate Finance and Investment and 11.432.J Real Estate Capital Markets will not be offered. Instead, MSRED students will be required to take 15.402 Finance Theory II in the spring term and a new two-term seminar in Real Estate Finance (11.921 and 11.922) designed to complement the Finance Theory courses. The seminars will be given by W. Tod McGrath, Lecturer in the Department of Urban Studies and Planning.

RESEARCH

Center faculty are engaged in a number of research projects. Professor of Economics William C. Wheaton has been researching the causes and consequences of the spatial dispersion of jobs in cities throughout the world. Others have documented the trend, but theoretical explanations are yet to be devised. In a paper to be published this year, Professor Wheaton shows that wages for identical workers vary by where they work and that work locations with more difficult commuting pay more. He has devised a model to explain this process, and will give a paper on this in Tokyo in August. He also has two Ph.D. students working on dissertations that extend this research to cases where workers continually move between jobs within cities. Henry Pollakowski, visiting scholar in the Department of Urban Studies and Planning, is doing follow-up work on his study of the Bermuda housing market for the Bermuda Housing Corporation. He also completed an initial simulation model which projects state sales tax losses stemming from internet retail growth. This research, the first to deal seriously with location and detailed product lines, is being done jointly with the University of Wisconsin and supported by the International Council of Shopping Centers.

Professor Riddiough published some of his recent work on Real Estate Investment Trusts as a working paper entitled "Unsecured Debt and Financial Policy of Real Estate Investment Trusts." That study finds that firms seem to manage to target leverage ratios in order to maintain a minimum credit rating. Professor Wheaton published a working paper, "Ski Resort Real Estate Markets: Why Not to Invest." based on thesis research done by co-author, John D. Corey '00. They find that resort supply responds so elastically to any movement in prices or business that it effectively curtails any long term property appreciation. Professor Pollakowski's study, "Monitoring Housing in Bermuda: Recommendations," was published as a working paper. It is a thorough discussion of the rationale, and strategies for collecting data on the Bermuda housing market.

For a fifth year, the center hosted visiting scholar, Henry Pollakowski, housing economist and editor of the *Journal of Housing Economics*.

PROFESSIONAL EDUCATION

The sixteenth summer of professional development courses brought 296 attendees to campus in June and July of 2000, a substantial decrease from the previous summer's attendance. Attendees enrolled in nine courses, including one new course, "Structuring Complex Real Estate Transactions," which was very well received. Another new course, "Advanced Real Estate Negotiations," also did somewhat better than projected. Attendance at real estate capital markets courses was way off. Encouragingly, enrollment in the center's 2001 Summer Institute courses was running well above 2000 figures at the end of June. There were two new courses in 2001: one on "Benchmarking Real Estate Investment Management and Performance Measurement," taught by MIT Ph.D., Professor David Geltner of the University of Cincinnati, and Professor Riddiough's "Innovations in Real Estate Finance."

MEMBERSHIP

Income from membership declined as the center closed the year with 68 supporting members (including six international members). This represents a net loss of 23 over the previous year, however, 15 of the members who left had joined as part of a special fund raising effort and were not expected to maintain their memberships long-term. Also, Chairman Blake Eagle, who has led the effort to recruit and maintain member companies, left the center in December as part of a planned transition, although the new chairman could not take office until June. In addition to annual fees, many members supported the center in non-financial ways by providing case study sites, lecturing in class, and supporting student thesis work. For a fifth year, Robert Danziger, retired Chairman of member firm Northland Investment, organized and led the well-received Real Deals speaker series.

The center hosted a lively and well-attended members meeting in November for corporate supporters, current students, and faculty. The topic of the meeting was the impact of the internet and other new technologies on the demand for real estate. The dinner speaker was Center Director, Professor Wheaton, who presented an overview of the topic, concluding that "telecommunications make it less and less likely that real estate asset prices are ever going to appreciate above inflation," an unpleasant finding for his audience. The following morning a group of practitioners and academics including MIT Professor of Engineering Systems, David Simchi-Levy, gave their views on technology impacts on the industrial, retail, hospitality, and office sectors of the real estate market.

A smaller meeting of members, faculty and students in May, entitled "Development Finance: Irrational Conservatism," examined the apparent constraints on the current availability of capital for development. Edward J. Kane, Cleary Professor of Finance at Boston University was the dinner speaker, explaining his view of the state of current capital markets. The next morning, speakers representing capital suppliers, regulators, and developers gave their views on the relative availability of construction and take-out financing. In general, existing constraints were agreed to be rational and necessary.

ADMINISTRATION

After seven years at MIT, Chairman Blake Eagle left in December to become President of the National Council of Real Estate Fiduciaries. His successor, John T. Riordan, formerly president of the International Council of Shopping Centers, and well known in the real estate industry, took up residence at MIT in June. Director, Professor William Wheaton and Associate Director, Marion Cunningham continued in their posts this year.

The refurbishing of the center's quarters continued this year with a face-lift of the central office area. The redesigned workspace provides quieter and more private accommodations to the support staff. The work was paid for from the center's accumulated operating surplus. Instigated by a Class Gift and leadership from members of the Class of 2000, planning was begun to update carpet, paint, and furnishings in the student lounge and adjoining conference room. That project is scheduled for completion in the fall of 2001.

Information about center programs is published online at http://web.mit.edu/cre/www/. This is also the primary source for public inquiries about the MSRED program, professional development courses, and working papers. Planning for a web site redesign was initiated in the spring as a result of a reassessment of the center's marketing strategy. The redesign should be complete in FY2002.

William C. Wheaton

MEDIA LABORATORY

For the Media Laboratory, 2000-2001 can be characterized as a year of expanding boundaries–both intellectual and global. While continuing to develop technologies that make the digital world more meaningful, livable, and responsive to our everyday needs, the Lab is also focusing on ways to make these technologies–and the societal benefits they can bring–accessible to the most remote areas of the world. As part of this effort, in June 2001 the Lab announced a one-year exploratory project with the government of India to create Media Lab Asia. The goal is to work with the government of India and local non-government organizations to apply the most sophisticated emerging technologies to the daily problems of India's poorest and least educated people.

Eight months earlier, in October, more than 200 people from nearly 40 nations came to the Lab to launch Digital Nations, a new consortium focused on helping people in developing areas become fluent in digital technologies. The goal is for people from all walks of life to use these technologies to develop innovative local solutions to local problems. Other ongoing initiatives with global outreach include LINCOS, a joint project with the Costa Rican Foundation for Sustainable Development, which brings wireless "digital town centers" to remote areas of Latin America; ThinkCycle, a "grassroots" initiative by several Lab graduate students to create an online database to enable open-source, technical problem solving among university students everywhere; and the Center for Digital Culture, a joint Media Lab/Telmex initiative in Mexico City, which is seeking opportunities for technological advances that derive naturally from cross-cultural exchange, where the potential for human application is greatest.

The past year has also brought significant changes to the administration of the Lab. In September, Nicholas Negroponte, director since the Lab's founding in 1980, announced that he would take on the newly created position of senior director, a "chairman-like" role that more accurately reflects his increased attention to external and international relations. Walter Bender, a researcher at the Lab since its inception and head of the Electronic Publishing group, was named executive director, with a focus on internal growth and development of the Lab's research and sponsor relations. Sony Career Development Professor John Maeda, head of the Aesthetics and Computation group, was named associate director, and will focus on design and communication.

The Lab has also experienced numerous physical moves–including a newly established "outpost" at One Cambridge Center–as temporary measures to handle its considerable growth over the past several years. The long-term solution involves a major expansion that includes the construction of a seven-story building designed by Fumihiko Maki, and a complete renovation of the Lab's current building. The project, which will roughly double the current footprint of the Lab, is slated for completion in 2004.

RESEARCH ACHIEVEMENTS

A sampling of 2000-2001 Media Laboratory research accomplishments includes:

The microfabrication of an ***interferometric accelerometer*** that offers advantages over existing accelerometers in terms of resolution, size, and potentially low cost. Lab researchers have manufactured 14 accelerometer devices capable of detecting accelerations at the micro-g and nano-g levels, on a single 4-inch silicon wafer.

A new technology to mass-produce ***super-cheap transistors*** by printing them directly onto a plastic substrate using a solution of cadmium selenide nanocrystals.

Expressive Footwear (sneakers to be exact) that sport a wireless suite of sensors, a microcomputer, and a data link that measure more than a dozen different parameters of motion and feed this information wirelessly into a PC, which uses a unique program to turn the movements into sound. This project won a 2000 *Discover Magazine* Award for Technical Innovation.

Periscope, a browsing device that allows a user to explore the physical world by navigating its digital shadow–in this case, Web pages situated at the places they represent in the real world.

A prototype for a ***hand-held, human-powered generator*** that creates five watts of power by being twirled over a person's head by a string. The device has implications for providing affordable power for simple computers in the poorest and most remote areas of the globe.

Wireless ***"digital town centers,"*** capable of providing even the most remote and underdeveloped areas of the world with telephone, e-mail, and Web access. The centers are designed to bring new forms of medical care, education, entertainment, and commerce to the remote areas.

Wearable computing, which allows us to move beyond PCs and laptops and wear our computers as we would eyeglasses or clothing. One project, ***MIThril***, combines light-weight RISC processors, a single-cable power/data "body bus" and high-bandwidth wireless networking in a package that is nearly as light, comfortable, and unobtrusive as ordinary street clothing.

Expressive ***synthetic characters*** that inhabit virtual environments and interact autonomously in response to users' actions, appearing to have minds of their own.

New ways of joining the physical environment and cyberspace by making ***"tangible bits"*** accessible through everyday physical surfaces like walls or desktops, and eventually through household surfaces like refrigerator doors. One new project, ***ComTouch***, focuses on providing haptic, interpersonal communication to help those who are the deaf and blind communicate through touch.

A new class of ***low-cost, wireless sensors*** that can be used to bring digital functionality to low-cost consumer products. An example would be a 5-cent wireless temperature sensor that could be embedded in cookware or packaging for food or medicine.

More effective, meaningful ***online news services***. These range from Time Frames, a tool to make online news more relevant by augmenting a general news source with small amounts of temporally correlated information, to Brico, a computer knowledge base that utilizes the meaning of words to create "sense tagging" for multilingual translations.

Autonomous agents capable of having a real-time, face-to-face conversation with a human. These agents are human in form and communicate using both verbal and non-verbal modalities.

Chat Circles, an abstract graphical interface for synchronous conversation, creating a richer environment for online discussions.

New techniques for ***information hiding***, including the groundbreaking use of mid-level vision models and the placement of unique identifiers on physical objects.

Toy Symphony, a three-year project involving children, soloists, composers, and symphony orchestras around the world, which aims to radically alter how children are introduced to music, and to redefine the relationship between professional musicians and young people.

A handheld ***digital mirror*** that serves as a simple, everyday diagnostic imaging tool for people to "photograph" health indicators, such as blood sugar levels or heart rate.

Collaborations within MIT
In addition to the more than 250 research projects under way within the Lab's more than 30 research groups, numerous research initiatives involve a broader MIT collaboration. These include:

The ***Caltech/MIT Voting Technology Project*** (funded by the Carnegie Corporation), which seeks to provide the first comprehensive study of voting technology to be completed in the wake of the 2000 U.S. national election.

Joint efforts with the Program in Science, Technology, and Society, the Sloan School of Management, and other MIT departments and programs in developing ***Media Lab Asia***.

A major collaborative bioengineering project with the Departments of Chemical Engineering, Biology, Electrical Engineering and Computer Science, and the Division of Bioengineering and Environmental Health, to develop three ***novel devices to detect molecular activity***: a single-electron transistor, a scanning-probe potentiometer, and a cantilever stress sensor.

MEDIA LAB EUROPE

Media Lab Europe (MLE) was launched in Dublin on 24-25 July 2000, with a major symposium attended by some 400 invitees from the academic, business, and arts communities. In December, Rudolph Burger, an expert in digital photography and a former Xerox Corporation vice president, was named chief executive officer and director, replacing Nicholas Negroponte who had served as interim CEO and who remains as chairman of the Board of Directors.

MLE expects its research staff and graduate student population (many of whom have come from the Media Lab) to number approximately 40 by September 2001. Current research groups include Affective Feedback, Nanostructures,

and Everyday Learning. In addition, MLE has initiated more than 10 collaborative projects with Irish universities–ranging from "Intelligent Sensing Systems for Science Education and Bio-Monitoring" to "A Multilingual Development Environment for Speech Technologies." On June 21 MLE hosted a major event, Cross Currents, attended by some 120 representatives of European corporations, at which researchers from both MLE and the MIT Media Lab presented their work. Four other workshops involving MIT faculty were held this past spring: Software Agents, Context-Aware Computing, Narrative, and e-Communities.

MLE sponsors are: eircom, Ericsson, Intel, Allied Irish Bank, BBC, RTE (Irish Broadcaster), and 360networks. Equipment donors include Hewlett-Packard, Compaq, and Motorola.

SPONSORS

In Fiscal Year 2001, the Media Laboratory received a total of $36.1 million from sponsors, an increase of 18 percent over Fiscal Year 2000. Corporate sponsors provided over $34.6 million of that amount; the remaining $1.5 million came from government funding, non-profit organizations, and subcontracts with other universities.

RESEARCH SPONSORS

New directed-research sponsors included: Eastman Kodak, which supported the work of Henry Lieberman on common-sense knowledge, and France Telecom, which supported Professor Justine Cassell and her Gesture and Narrative Language research group.

The Media Laboratory was awarded government grants for several directed research projects in FY'01. These include: "Foundations for Quantum Algorithms" (Professor Isaac Chuang), from the Army Research Office; "Micro and Nanoscale Electronic Devices for Analyzing DNA and Proteins" (Professor Scott Manalis), from AFOSR; and four DARPA-funded projects: "Modeling, Creation, and Analysis of Adaptive Agent Systems" (Oliver Selfridge), "Architectures and Applications for Scalable Quantum Information Systems" (Professor Isaac Chuang), "RF (Radio Frequency) Nixels" (Professor Joseph Jacobson), and "Cell Biological Decision Processes" (Professor Scott Manalis).

In addition, the National Science Foundation provided grants to Professor Deb Roy for "Multimodal Learning for Assistive Aids," to Professor Rosalind Picard for "The Role of Emotion in Propelling the Learning Process," and to Professor Mitchel Resnick for "The PIE Network."

Corporate research partners

Learning Lab Denmark joined the Media Laboratory in Fiscal Year 2001 at the Strategic Research Partner level, which gives them membership in all of the Lab's consortia and special interest groups.

CONSORTIA

In FY'01 the Lab announced the formation of a new consortium, **Digital Nations**, which addresses major social challenges through the innovative design and use of new technologies. Its ultimate goal is to empower people in all walks of life to invent new opportunities for themselves and their societies.

The **News in the Future** consortium is now **information: organized (I:O)**, to reflect its broader focus on how information is described, presented, and used. LG Career Development Professor Brian Smith is the consortium's new head.

New sponsors joining the Lab's consortia include:

Digital Life: 360networks, Inc., Deutsche Telekom AG, Hallmark Cards, Inc. and Sprint/United Management Company.

information: organized: McGraw-Hill

Things That Think: Consignia PLC, engeneOS, Inc., France Telecom, Pitney Bowes, Inc., and Zyomyx, Inc.

SPECIAL INTEREST GROUPS

A new **Health** special interest group (SIG), was established in FY2001. Combining research in the areas of nanotechnology, biosensors, body networks and smart homes, it explores ways to give consumers the tools to take control of their health and maintain their lifestyle. Research areas include: development of microfabricated biosensors for health and lifestyle maintenance; wearable systems and smart environments; data-rich, personalized medical science; and feedback systems for reinforcing healthy behavior and medical compliance, and for promoting self-knowledge.

Penny PC has spun off into three more specialized SIGs:

IPID, which looks beyond low-cost tags to ask how billions of inexpensive communicating objects can be tied together into coherent systems, and which serves as an interface for sponsors to participate in activities of MIT's Auto-ID Center;

Silicon Biology, which explores how micro- and nanoscale fabrication technologies offer fundamentally new ways to probe, understand, and ultimately control complex biological systems; and

Personal Fabrication, which focuses on making things, and the future of how things are made, from nano- to macroscale. It has two basic goals: first, to involve members in learning new fabrication techniques (CAD tools, 3-D printing, laser cutting, vacuum forming, AFM assemblers), and to introduce them to the latest developments in rapid and desktop fabrication; and second, to explore the future of the desktop fabrication.

SPECIAL FUNDS

Several of the Laboratory's most generous sponsors continued to support the Laboratory through corporate fellows programs. In total, ten corporations supported fellowship programs during FY'01.

Four sponsors, Intel, Mattel, National Geographic Society, and Telmex funded new fellowship programs, while BT, eircom, IBM, LEGO, McDonald's, Motorola, and Toshiba continued ongoing programs, supporting the following fellows:

BT: Aggelos Bletsas, Vanessa Colella, Paulo Rocha e Oliveira, Joseph Pompei, Nitin Sawhney, Edison Thomaz, and Jim Youll

eircom: Constantine Christakos, Aisling Kelliher, Jonah Peretti, Jung-Hoon Seo, Ramesh Srinivasan, and Sean Wheeler

IBM: Mark Feldmeier, Vadim Gerasimov, Karrie Karahalios, Jeremy Levitan, Casey Reas, Casey Smith, Brygg Ullmer, and Sunil Vemuri

Intel: Bill Butera, Danah Boyd, Ben Piper, Jared Schiffman, and Dimitris Vyzovitis

LEGO: Mike Ananny, Rahul Bhargava, and Claudia Urrea

Mattel: Catherine Vaucelle

McDonald's: LaShaun Collier, Joseph 'Jofish' Kaye, Wendy Ju, and Daniel Stevenson

Motorola: Barbara Barry, Rick Borovoy, Rich Fletcher, Nin Loh, Cameron Marlow, Matt Reynolds, and Adam Smith

National Geographic Society: Andrew Wheeler

Telmex: Ernesto Arroyo, Marco Escobedo, José María González Pinto, Jorge Martínez, Marco Monroy, Selene Mota, and Juan Rivas

Toshiba: Ari Benbasat, Angela Chang, and Rich DeVaul

GIFTS OF EQUIPMENT

In Fiscal Year 2001, United Technologies Corporation signed an agreement to provide the Media Lab with more than $5 million worth of equipment to be part of the infrastructure of the new Media Laboratory building. In recognition of this, these systems will be known as the United Technologies Corporation Intelligent Building Infrastructure Testbed Laboratory.

PERSONNEL

New appointments

Sherry Lassiter was appointed as program manager for the Things That Think consortium in March 2001. A recipient of a Knight Science Journalism Fellowship at MIT in 1993–94, Lassiter has also worked as a science documentary television producer, writer, and director in the Boston area, and on national television series such as *Scientific American Frontiers*.

The Lab made several new administrative appointments during the past year: Ariane Martins was given a three-year appointment as program manager for the Toy Symphony Opera, Peter Rombult was appointed as a grants administrator for the Lab, Stacie Slotnick was appointed writer/content manager in the Office of Communications and Sponsor Relations, and Robert Hayden, David Lieberman, and Keith Odom as Lab fiscal officers.

The Lab also made several research staff appointments during FY2001: David Cavallo was given a three-year appointment as research scientist in the Future of Learning group; Ryan Chin was given a one-year appointment as research specialist in the CC++ special interest group; and Diane Willow was given a three-year appointment as learning projects designer in the Lifelong Kindergarten group.

Four technical staff members were hired: Stephen Berezansky, a desktop computing specialist; Thomas Greene, a systems engineering/support specialist; and Will Glesnes and Jon Ferguson, both whom resigned last year to join start-up companies, returned to the Lab this past spring.

Promotions
Several administrative assistants were promoted to staff during FY2001: Melissa Corley was promoted to project coordinator of Information:Organized; Joanna Hills was promoted to administrative coordinator of the Human Resources Office; Meg Kelly-Savic was promoted to administrative coordinator for the Program in Media Arts and Sciences headquarters' office; Colleen Lefebvre was promoted to fiscal office manager; Karen Navarro was promoted to project coordinator for the Health Special Interest Group; and Connie Van Rheenen was promoted to executive coordinator in the Associate Director's Office.

There were several promotions of staff during the past year: James Blanchflower, who has served as fiscal officer for the Lab since 1993, was promoted to associate director for accounting; Susan Bottari was promoted to executive assistant for the Things That Think consortium; John DiFrancesco was promoted to fabrications resources manager; Julie Fresina was promoted to facilities manager; Betty Lou McClanahan was promoted to executive director of the CC++ special interest group; and Greg Tucker was promoted to director of facilities.

New visitors and affiliates
Anna Pandolfo was appointed as visiting scholar in the information: organized group from July 1, 2000 through July 1, 2002. Ed Hammond was appointed as research affiliate for the Media Lab/Media Lab Europe collaboration from September 1, 2000 through August 31, 2001. Mario Fromow Rangel from Telmex was appointed research affiliate from October 1, 2000 to June 30, 2001. Magda Ismail was appointed as visiting scientist for the Harvard/Digital Nations collaboration from November 27, 2000 through November 27, 2001. Rudy Burger, Chief Executive Officer of Media Lab Europe, was appointed research affiliate from December 1, 2000 through November 30, 2001. Eleanora Badilla-Saxe was appointed as visiting scientist for the Digital Nations Consortium from January 1, 2001 to December 31, 2002.

The following researchers from BT Laboratories were appointed to the Media Lab as research affiliates: Ian Neild, from December 1, 2000 through November 30, 2001; and Steven Whittaker, from February 1, 2001 to January 31, 2002.

Two employees from the U.S. Postal Service were appointed to the Media Lab as research affiliates: Pat McGee, from April 1, 2001 to March 31, 2002; and Kenneth Paul from April 16, 2001 through April 15, 2002.

Susumu Kubota from Toshiba Corporation was appointed as research affiliate from April 14, 2001 to April 13, 2002.

Jae-Chol Lee was appointed as visiting scientist from June 11, 2001 to August 31, 2001.

Tom Gardos from Intel was reappointed as research affiliate for a second year from June 14, 2001 to June 14, 2002.

Resignations
Tanya Pfeffer, administrative computing support specialist, left the Lab to relocate to Minnesota; Chad Brustin, project coordinator of the Arts and Expression group, left the Lab to relocate to Arizona.

More information about the Media Laboratory can be found at http://www.media.mit.edu/

Walter Bender

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June 2001

DEAN, SCHOOL OF ENGINEERING

By creating, developing, organizing, and managing complex technologies and products, engineers play a crucial role in shaping and improving our world. Engineers seek solutions to the most difficult challenges of our day in the context of physical, economic, human, political, legal, and cultural realities. In a world increasingly influenced by scientific and technological innovation, engineers can, and do, contribute vital leadership to society.

Currently, the School's eight departments and two divisions encompass a community of many of the world's brightest minds and most inventive thinkers—over 60 percent of MIT's undergraduates with declared majors, about 45 percent of MIT graduate students, and over one-third of the Institute's faculty. Third party ratings routinely rate the School's departments as the best in their fields.

During the 2000–2001 academic year, the School undertook several major initiatives that underscore its commitment to maintaining leadership in shaping engineering education and research. This report presents selected highlights of significant achievements of the School: innovations in education, partnering with industry, major priorities for the future, building and strengthening communities, special programs, accreditation of educational programs, and noteworthy celebratory events. In addition, the report includes updates on notable awards, personnel changes, and School statistics. The reports of the School's departments, divisions, laboratories, centers, and programs provide additional information about the past year.

INNOVATIONS IN EDUCATION

The School of Engineering has undertaken several ambitious projects to enhance and potentially transform the educational experience of its students and to create new models of education for engineering more broadly. Stimulated and supported by MIT's Council on Educational Technology (the d'Arbeloff Fund for Excellence) and by Project iCampus (see below), the School's faculty and students are leading innovative projects on the use of new technologies. Additionally, the faculty is actively engaged in several collaborative and global learning initiatives that utilize and develop advanced technologies.

Cambridge-MIT Institute

On July 21, 2000, representatives from MIT and from Cambridge University and the United Kingdom signed an agreement officially creating the Cambridge-MIT Institute (CMI), a collaborative program between MIT and Cambridge University. Through a variety of means—student exchanges, collaborative research between Cambridge and MIT faculty, the development of new professional educational programs in technological fields, collaboration on innovative undergraduate education, and collaboration with eight British universities designated as Enterprise Centers—CMI aims to stimulate the development of new technologies, to encourage entrepreneurship, and to improve productivity and competitiveness.

During the Spring term, seven juniors from the School of Engineering studied at the University of Cambridge, the first MIT students to participate in CMI. Through CMI, approximately 30 juniors from MIT expect to study at Cambridge and 30 of their Cambridge counterparts will come to MIT during the 2001–2002 academic year.

OpenCourseWare

As announced by President Charles M. Vest in April, over the next decade, through a new initiative called OpenCourseWare (OCW), MIT plans to provide course materials used in the teaching of almost all undergraduate and graduate subjects on the web, free of charge, to anyone, anywhere in the world. A pilot program being planned for fall 2001 would make the first OCW materials available in spring 2002. MIT plans to make over 500 courses available on the World Wide Web through OCW over the next two and a half years.

The School of Engineering played a seminal role in MIT's conception, development, and adoption of OCW. Last summer, Dick K. P. Yue, Associate Dean of Engineering and Professor of Hydrodynamics and Ocean Engineering, chaired the study group that developed the idea of OCW. During last Fall and this Spring, Professor Yue, together with Harold Abelson, the Class of 1922 Professor of Electrical Engineering and Computer Science and co-chair of the Council on Education Technology, and Steven Lerman, professor in the Department of Civil and Environmental Engineering and chair of the faculty, were instrumental in communicating and articulating OCW within the MIT community and with outside sponsors. The latter activity resulted in the June 2001 announcement of two grants to MIT OCW, totaling $11 million, by the Andrew W. Mellon Foundation and the William and Flora Hewlett Foundation for the first 27-month pilot phase of OCW.

MIT OCW is a bold technology-enhanced educational initiative that has the potential to lead to fundamental changes in the way colleges and universities use the web as a vehicle for education.

Project iCampus

In October 1999, Microsoft and MIT announced an alliance to enhance university education through information technology. Named "Project iCampus," the collaboration involves cooperative projects among members of Microsoft Research and students, faculty, and researchers at MIT, particularly in Engineering.

Leveraging many of the successful inventions and innovations in computers and telecommunications that have occurred in the last half of the 20th century, the partnership aspires to use modern information technologies to develop new pedagogical approaches and structures, integrating information technology concepts and methods throughout university education, and addressing the changing environment of the university.

Two School of Engineering projects serve as examples of educational innovation and enhancements that iCampus is supporting. A project jointly undertaken in the Department of Aeronautics and Astronautics and in the Department of Civil and Environmental Engineering is offering students active learning and hands-on experiences in the classroom, in the laboratory, and during design and distance collaboration. This project is developing distance collaboration and design curricula in learning environments with design teams that span department, institutional, and cultural boundaries; developing a methodology, and associated software, for improving learning in the classroom; and developing simulation environments as tools for active learning in the undergraduate learning laboratory. The project utilizes new technologies not previously incorporated into the classroom at MIT, for example, a personal response system (PRS) that permits real-time student responses and feedback in class so that students and faculty can more readily identify and address the most important learning concepts and impediments.

Another iCampus project allows MIT students to access novel online, real-time laboratories from dorm rooms and other locations 24 hours a day. With an initial focus on a "WebLab" in Electrical Engineering and Computer Science, I-Lab permits students to test and probe fragile, microscopic electronic structures, such as transistors. The I-Lab concept has the potential to transform science and engineering education by providing online access to a variety of state-of-the-art labs. WebLab gives students a new framework for carrying out experiments, synthesizing information, and relating it to underlying theory. The I-Lab project has undertaken to extend the laboratory experience for students at MIT; explore the portability of the web-accessible remote laboratory concept to other engineering disciplines, such as Chemical Engineering and Mechanical Engineering; construct a rich educational platform around WebLabs that integrates tools for simulation, collaboration, semiautomatic feedback, and evaluation; and develop a "universal" architecture and software framework for WebLab and I-Lab development.

Singapore-MIT Alliance

The Singapore-MIT Alliance (SMA) is an innovative global engineering education and research collaboration among the National University of Singapore (NUS), Nanyang Technological University (NTU), and MIT. Promoting global engineering education and research, SMA stretches across 12 time zones to offer several graduate degree programs. Having grown from two programs, this year SMA offered graduate education in Advanced Materials for Micro- and Nano-Systems, Innovation in Manufacturing Systems and Technology, Molecular Engineering of Biological and Chemical Systems, Computer Science, and High Performance Computation for Engineered Systems. SMA utilizes leading-edge communications technologies in what might be the largest distance education collaboration in the world today. During this year, 43 MIT faculty from six departments and two schools collaborated with 46 Singaporean colleagues to provide graduate education and research supervision to 133 SMA students. Many SMA courses are offered simultaneously to students in Singapore and at MIT; more than 200 MIT students have participated in these subjects since September of 1999. In July 2000, SMA celebrated its first anniversary.

PARTNERING WITH INDUSTRY

Historically, industrial research collaborations undertaken by MIT and the School of Engineering have created new knowledge and transferred science and technology into industry, resulting in the creation of jobs, companies, and even new industries based on new technologies. In recent years, MIT has become a leader in developing research and education partnerships with industry, many anchored in the School of Engineering. For the School's graduate and undergraduate students, these industry collaborations also bring significant real-world technology and engineering issues into their studies.

MIT Alliance with the Hewlett-Packard Company

The Hewlett-Packard Company (HP) and MIT signed an agreement in August 2000 to form a $25 million alliance to develop innovative ways to create and manage digital information. The five-year alliance will investigate new architectures, devices, and user-interfaces in information-rich environments and explore novel services for commerce, education, and personal use. Capitalizing on the longstanding collaboration between HP and MIT, especially the School's Department of Electrical Engineering and Computer Science (EECS), the HP and MIT alliance will address and support research and educational programs of mutual interest. In addition to projects planned with the MIT Libraries and the Sloan School, projects undertaken with Engineering involve the Laboratory for Computer Science, the Artificial Intelligence Laboratory, the Laboratory for Information and Decision Systems, and the Research Laboratory of Electronics.

Oxygen Alliance

In July 2000, the Laboratory for Computer Science (LCS), in association with the Artificial Intelligence Laboratory (AI Lab), held a two-day "Oxygen summit" to announce the formation of the Oxygen Alliance, a group of companies that will work with MIT researchers to advance and integrate the technologies of the $50 million, five-year Oxygen project. The companies—including the Acer Group, Delta Electronics, Inc., Hewlett-Packard Co., Nippon Telegraph and Telephone Corp., Nokia Research Center and Philips Research—will work with MIT researchers to create a new breed of pervasive, human-centered computers devoted to serving people's needs. First

announced at the LCS's 35th anniversary celebration in April 1999 and launched in the Fall of 1999 with seed funding from the Defense Advanced Research Projects Agency (DARPA), the MIT Oxygen project involves some 250 researchers at LCS and the AI Lab. The Oxygen Alliance will entail collaborative research between the companies and MIT, including personnel exchanges and joint workshops and projects.

MAJOR PRIORITIES FOR THE FUTURE

In the past few decades, the world has fundamentally changed in many ways: today's watchwords include environmental sustainability, globalization, economic security, and pervasive technology. Exciting new opportunities in several emerging domains are transforming the future of engineering. Immersed in this environment of change, the School's Leadership Council (Engineering Council) has worked over the past year and a half to formulate a strategic plan for the School, identifying its major priorities for the future.

The School strives to make significant contributions to addressing the societal challenges of the 21st century by pursuing a course of leadership through technical excellence and innovation. The School aspires to:

- Cultivate a new generation of leaders—engineers who are leaders and entrepreneurs; engineers who understand the broad context of engineering and business; and engineers who are well versed in science and mathematics fundamentals as well as teamwork, organizations, and leadership. The School seeks to recruit, retain, and reward a broad and exemplary community through commitment to diversity, graduate fellowships, faculty support and development, and educational innovation.
- Invest in new vectors of research—bioengineering, tiny (micro- and nano-) technologies, engineering systems, and information engineering. In addition, the School seeks to support the creation of innovative technologies through a Technology Research Ignition program.
- Create an environment for innovation—the School seeks to create, renew, and renovate the infrastructure for engineering education and research. Major facilities include the Ray and Maria Stata Center for computer, information, and intelligence sciences, a nanofabrication facility, and other infrastructure improvements and space for new activities.
- Build upon the excellence of the School's departments, divisions, laboratories, centers, and programs.

To fulfill this ambitious plan requires significant resources. Consequently, the School has undertaken a major fundraising campaign to underwrite these important priorities.

BUILDING AND STRENGTHENING COMMUNITIES

The School of Engineering continues its dedication to building and strengthening communities.

Diversity

The School has a long-standing commitment to build a community of faculty, students, and staff that is both world-class and diverse. It continues to actively pursue these goals and has made increasing diversity one of its major priorities for the future. Over the coming years, the School plans to explore, develop, and implement a range of programs and services that create an environment that promotes and achieves student and faculty diversity.

The School of Engineering currently comprises about 34 percent women at the undergraduate level, 18 percent at the graduate level, and 9 percent at the faculty level, compared to national figures for engineering schools of 18 percent, 11 percent, and 4 percent respectively. This past year, a School Committee on Women Faculty embarked upon an intensive study of the current environment for women faculty in the School. The committee intends to issue a report with its findings in the fall.

In September, Provost Robert A. Brown announced the appointment of a 12-member Council on Faculty Diversity to aggressively promote racial and gender diversity of the faculty. Four members of this council are professors in the School of Engineering, including Dean Magnanti. In January, MIT hosted an unprecedented all day dialogue on equitable treatment of women faculty in science and engineering attended by presidents, chancellors, provosts, and 25 women professors of nine top research universities.

Also in September, President Charles M. Vest and Professor Steven R. Lerman, chair of the faculty and professor in the Department of Civil and Environmental Engineering, appointed 11 MIT professors to a new Task Force on Minority Student Achievement. The task force is charged with assessing and reviewing whether gaps exist between predicted and actual academic performance of MIT minority students and, if so, identifying the reasons for the gaps and recommending strategies to address this situation. The members will consult with experts inside and outside MIT as necessary. The task force includes five professors from the School and Mr. Karl Reid, executive director of the School's Special Programs (see below), provides principal staff support.

IdeaStream

In February, the School of Engineering hosted a major conference, called IdeaStream, bringing about 140 venture capitalists to campus to exchange ideas with MIT faculty who are creating the intellectual capital and innovations that are fueling next-generation technologies. The conference included panels on communications, tiny technologies, bioengineering, and networked software.

SPECIAL PROGRAMS

The School of Engineering currently offers two special programs and will add another in the coming year.

Minority Introduction to Engineering, Entrepreneurship, and Science (MITE^{2}S)

This year, the MITE^{2}S program selected a record 80 underrepresented minority high school seniors to participate in its rigorous, six-week session, featuring two new courses in Robotics and Internet Programming. Chosen from over 650 applications, the selected students come from 29 states and Puerto Rico. Reflecting the more diverse professional interests of the students, this year's session expands on a career seminar series by incorporating talks on science and medical professions as well as engineering. A mix of corporations, foundations, MIT alumni, and parents of former participants has made major contributions in support of the 2001 session. More significantly, the program received $3.6 million in pledges and gifts toward the MITE^{2}S endowment from two sources. Of the 62 students who attended MITE^{2}S 2000, 45 applied to MIT and 42 were accepted. Nineteen of the latter will attend MIT this year.

Engineering Internship Program

During the summer of 2001, 33 students will participate in Engineering Internship Program (EIP) internships: nine from Aeronautics and Astronautics, and 24 from Mechanical Engineering. Given an increase in choices among summer internships, summer jobs, and five-year master's programs available to School of Engineering students, the School will phase out EIP by 2005.

Saturday Engineering Enrichment and Discovery (SEED) Academy

In the 2001–2002 academic year, the MITE^{2}S Program will launch a 16-week Saturday program for 20 local minority 9th graders designed to strengthen fundamental mathematics, science, and communications skills in the context of hands-on engineering projects. A corporation, foundation, and an MIT alumnus provided outside funding for the first year of the program. At full capacity in 2004–2005, the SEED Academy will host 80 students from four Cambridge and Boston high schools.

ACCREDITATION BOARD FOR ENGINEERING AND TECHNOLOGY, INC.

In the fall of 2001, the School of Engineering will seek Accreditation Board for Engineering and Technology, Inc. (ABET) (re)accreditation of thirteen undergraduate programs from eight academic departments. This is the first time MIT will participate under the new ABET Criteria 2000. In January 2000, the School convened an ABET Working Group, with faculty representatives from the academic units and chaired by the Associate Dean of Engineering, Professor Dick K. P. Yue, to coordinate and facilitate activities in preparation for the ABET review. Due to the change in accreditation criteria, each program must articulate clearly defined program objectives and outcomes and establish formal procedures for continual assessment and improvement. These are now in place for every undergraduate program in the School. Looking beyond ABET accreditation, the School plans to work with the departments to implement and maintain plans and procedures for ongoing assessment and improvement of their programs focused on student learning.

NOTEWORTHY CELEBRATORY EVENTS

In September, the Department of Aeronautics and Astronautics held a two-day celebration to launch its new Learning Laboratory for Complex Systems and introduce a new educational curriculum. MIT faculty, industry leaders, astronauts, alumni, students, and guests participated in a special program examining the past century of the department and aerospace and featuring topics ranging from the human exploration of Mars and beyond to the development of engines the size of a shirt button. Sixteen young alumni of the department received recognition for their "innovation and vision for the future [that] will help to create a future of opportunity." A ribbon-cutting ceremony marked the opening of a world-leading teaching laboratory that integrates teaching laboratories, a prototype shop, integrated product development areas, a high-bay hangar space for student projects, and a hands-on engineering classroom into one interactive, interdisciplinary learning environment. The lab is an essential element in the department's mission to prepare engineers for success and leadership in the Conception, Design, Implementation, and Operation (CDIO) of aerospace and related complex high-performance systems.

In October, the Brit and Alex d'Arbeloff Laboratory for Information Systems and Technology in the Department of Mechanical Engineering celebrated its fifth anniversary. The lab's mission has been cross-disciplinary research and education using "information" as a catalyst to unlock new possibilities in mechanical engineering. A conference to mark the two-day celebration included both a lecture series on "Grand Challenges in Information Systems and Technology for the 21st Century" and a meeting of the lab's Home Automation and Healthcare Consortium that addresses information technology in health care. Topics highlighted during this event ranged from quantum computing and terabit switchers to future supply chains, distribution systems, and space explorer robots in the year 2040, as well as wireless Internet, a wearable computer mouse, and collective vision to tetherless health monitoring and robotic elder care. An open house featured demonstrations of several technologies, such as bioinstrumentation, telemedicine, nanotechnology, applied optics, and intelligent robots.

PERSONNEL

Professor Merton C. Flemings, Toyota Professor of Materials Processing, stepped down from his position as MIT Director of the Singapore-MIT Alliance (SMA), effective February 28, 2001. The Governing Board of the SMA

named Professor Anthony T. Patera of the Department of Mechanical Engineering as the new MIT Co-Director, effective March 1, 2001.

Ms. Mary Hanifin joined the Dean's Office staff as Director of Development for the School of Engineering, effective September 5, 2000. Ms. Hanifin previously worked in MIT's Office of Resource Development and, for seven of her eight years at MIT, supported the School's resource development efforts.

In August 2000, Institute Professor Thomas L. Magnanti, Dean of Engineering, became the MIT Co-Director of MIT's alliance with the Hewlett-Packard Company.

AWARDS

Each year faculty of the School of Engineering receive numerous honors in recognition of their research and service, many offered by professional societies and the faculties' professional communities, as well as national recognitions. This year was no exception. The reports of the School's departments, divisions, laboratories, centers, and programs make note of many of these awards. Several especially notable awards deserve additional mention here.

The National Academy of Sciences (NAS), elected to membership one Engineering professor, Provost Robert A. Brown, the Warren K. Lewis Professor of Chemical Engineering. The National Academy of Engineering (NAE) elected five School of Engineering faculty members to membership: Professor Dimitri P. Bertsekas of the Department of Electrical Engineering and Computer Science (EECS); Rafael L. Bras, the Bacardi and Stockholm Water Foundations Professor and Department Head of Civil and Environmental Engineering; Professor James G. Fujimoto of EECS; Professor Douglas A. Lauffenburger, the J. R. Mares Professor of Chemical Engineering, Professor of Bioengineering, Co-Director of the Division of Bioengineering and Environmental Health, and Director of the Biotechnology Process Engineering Center; and Nancy A. Lynch, the Cecil H. Green Professor of Computer Science and Engineering.

The American Academy of Arts and Sciences (AAAS) this year awarded the distinction of Fellow to four Engineering faculty and staff: Timothy Berners-Lee, the 3Com Founders Professor in the Laboratory for Computer Science; John Benjamin Heywood, the Sun Jae Professor of Mechanical Engineering and Director of the Sloan Automotive Laboratory; Shafira Goldwasser, Professor of Electrical Engineering and Computer Science; and Professor Lauffenburger (noted above). Berners-Lee was also named a Fellow of the Royal Society, the United Kingdom's National Academy of Science.

Associate Professor Vahid Tarokh of the Department of EECS won the Alan T. Waterman Prize, the National Science Foundation's highest honor for young researchers. He received the prize for transmission schemes known as space-time codes that significantly improve both the performance and data rates of wireless communication.

Institute and School Awards for Achievement, Leadership, Contributions to Education, Service

The Institute awarded the Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching to Professor Roger D. Kamm of the Division of Bioengineering and Environmental Health. Given in memory of Everett Moore Baker, Dean of Students from 1947–50, this award is presented to a faculty member in recognition of exceptional interest and ability in undergraduate instruction and is the only teaching award in which the nomination and selection of the recipients is conducted entirely by students.

The Amar Bose Award for Excellence in Teaching recognizes a faculty member whose teaching contributions over an extended period of time are characterized by dedication, care, creativity, and inspiration to students and colleagues. The School presented this award to EECS Professor Eric Grimson and presented the Junior Amar Bose Teaching Award to Professor Leonard McMillan, also of EECS, in recognition of his outstanding contribution to undergraduate education.

Professor Jesús del Alamo of EECS won the Class of 1960 Innovation in Education Award. This award recognized his dedication to excellence in teaching and his pivotal role in developing novel courses, projects, and instructional materials.

Professor Seth Lloyd of Mechanical Engineering was a recipient of one of this year's Edgerton Awards. These awards are given annually to honor Harold "Doc" Edgerton, Professor of Electrical Engineering and Institute Professor. Professor Lloyd, a leader in the field of quantum computing, was honored for his "combination of grounding-breaking, innovative research and teaching commitment."

Established in 1971 as a tribute to MIT's 10th president and former chair of the MIT Corporation, the James R. Killian, Jr. Award recognizes extraordinary professional accomplishment by full-time members of the MIT faculty. The Institute awarded the Killian Faculty Achievement Award for 2001–2002 to Erich Ippen, the Elihu Thomson Professor of Electrical Engineering and Professor of Physics, a world leader in the field of femtosecond optics whose techniques are employed in countless physics, chemistry, and biology laboratories.

Professor Wesley L. Harris of the Department of Aeronautics and Astronautics received a Leadership Award at the 27th annual Martin Luther King, Jr. Celebratory Breakfast. Professor Harris, an expert in the field of helicopter rotor

aerodynamics and acoustics, was honored as "an articulate spokesman for the causes of minorities as students and staff" and his outstanding presence as a role model.

In recognition of their devotion to undergraduate education at the Institute, MIT named two School of Engineering professors and two associate professors as 2000–2001 MacVicar Faculty Fellows: Professor Mary C. Boyce of Mechanical Engineering; Associate Professor of Materials Science and Engineering, Anne Mayes; Associate Professor in Civil and Environmental Engineering, Heidi M. Nepf; and J. Kim Vandiver, Professor of Ocean Engineering, Dean for Undergraduate Research, and founding director of the Harold E. Edgerton Center. The awards, given in memory of former Dean of Undergraduate Education and Professor of Physics Margaret L. A. MacVicar, recognize faculty members' excellence in teaching and innovation in education.

Institute Professor Thomas L. Magnanti, Dean of Engineering, received the Irwin Sizer Award for the Most Significant Improvement in MIT Education. The award, named in honor of Irwin W. Sizer, Dean of the Graduate School from 1967–75, recognizes significant innovations in MIT education.

The School presented the Ruth and Joel Spira Awards for Teaching Excellence this year to Professor Hari Balakrishnan of EECS, Professor Triantaphyllos Akylas of Mechanical Engineering, and Professor Emeritus Michael Driscoll of Nuclear Engineering. The Spira awards were established both to honor faculty for teaching excellence and in acknowledgment of the tradition of high quality engineering education at MIT.

Awards Received by Engineering Students

The Ron Brown Scholar Program named five MIT School of Engineering students as Ron Brown Scholars: Jordan Brewer and Francis St. Louis, both seniors in EECS; Charly Jeune, a sophomore in EECS; Marc Knight, a junior in EECS; and Sean Nolan, a sophomore in Aeronautics and Astronautics. The program recognizes African-American students who have demonstrated high academic achievement, strong leadership potential, and a clear sense of social responsibility.

Noah Warner, in Aeronautics and Astronautics, received the Henry Ford II Scholar Award, given to a senior in the School of Engineering who has attained the highest academic record at the end of the third year and who exhibits exceptional potential for leadership in the profession of engineering and in society.

Engineering students received two of three Barry Goldwater Scholarships given to MIT students this year. The award honors students who exhibit outstanding potential and intend to pursue careers in mathematics, the natural sciences, or those engineering disciplines that contribute significantly to the technological advances of the United States. Emily Craparo, a junior in Aeronautics and Astronautics, and Alexander Wissner-Gross, a sophomore in EECS, received the Goldwater Scholarships.

Christopher Gouldstone, a graduate student in Aeronautics and Astronautics, received the Goodwin Medal. This award, given in memory of Henry Manley Goodwin, the first Dean of the Graduate School, recognizes a graduate student whose performance of teaching duties is "conspicuously effective over and above ordinary excellence."

Brian Stoll and Chen Wang, graduate students in Chemical Engineering, received two of six Graduate Student Council Graduate Teaching Awards given for excellence in teaching a graduate-level course.

The Albert G. Hill Prize is awarded to minority juniors or seniors who have maintained high academic standards and made continued contributions to the improvement of the quality of life for minorities at MIT. Ebraheem I. Fontaine, a junior in Mechanical Engineering, and Luwam Semere, a senior in Chemical Engineering, received awards this year. A former vice president for research, Dr. Hill was an early champion of equal opportunity at MIT.

Desiree Ramirez, a Chemical Engineering major, received a Leadership Award at the 27th annual Martin Luther King, Jr. Celebratory Breakfast, for having devoted herself to racial and cultural interaction in the MIT community.

The Lemelson-MIT Student Prize for Inventiveness is an annual $30,000 cash award presented to an MIT senior or graduate student demonstrating remarkable inventiveness. The 2001 Lemelson-MIT Student Prize was awarded to Brian Hubert, a graduate student in Mechanical Engineering whose breadth of achievements includes innovations in nanotechnology, superconductor fabrication, memory chip design and fabrication, music, and architecture.

The Ronald E. McNair Scholarship Award recognizes black undergraduates who have demonstrated strong academic performance and who have made considerable contributions to the minority community. Created by the Black Alumni/ae of MIT in honor of Dr. McNair, who died in the explosion of the space shuttle Challenger, this year's award went to Jeannette Stephenson, a junior in EECS.

Four Engineering students received William L. Stewart Jr. Awards, which recognize contributions by an individual student or student organizations to extracurricular activities and events during the preceding year: Charles K. Boatin, a senior in Chemical Engineering; Satwiksai Seshasai, a senior in EECS; Chi-An Wang, a senior in Mechanical Engineering; and Paul K. Njoroge, a graduate student in EECS. The awards are given in memory of William L. Stewart Jr., an alumnus and member of the Corporation who showed deep interest in student life at MIT.

Awards to Engineering Staff
This year, the School launched a Rewards and Recognition program to recognize the achievements of the School's dedicated staff. In May, the School presented twenty "Infinite Mile Awards" at a well-attended School-wide celebration of excellence. The School awarded its first Infinite Mile Award for Team Excellence to a team in the Materials Processing Center: Jonathan H. Bartels, George B. Kenney, Frances M. Page, and Jennifer W. Pell. William C. Hanson of the Leaders for Manufacturing Program received the first School of Engineering Infinite Mile Award for Leadership. The following received Infinite Mile Awards for Excellence: Mindy L. Baughman, Department of Materials Science and Engineering (DMSE); Margaret S. Beucler, Mechanical Engineering; Kathleen R. Farrell, DMSE; Myron L. Freeman, EECS; Marion E. Gross, Mechanical Engineering; Gail P. Hickey, Technology and Policy Program; Anne M. Hunter, EECS; Doris L. Inslee, Laboratory for Information and Decision Systems; Joan M. Kravit, Mechanical Engineering; Ping M. Lee, Aeronautics and Astronautics; Debra A. Luchanin, Bioengineering and Environmental Health (BEH); Angelita Mireles, DMSE; Olga V. Parkin, BEH; Leslie Regan, Mechanical Engineering; and Marie A. Stuppard, Aeronautics and Astronautics.

STATISTICS FOR 2000–2001
The following statistics provide summary information about students, degrees awarded, and faculty.

Undergraduate Enrollment
1,985 students
34% women
21% underrepresented minorities

Graduate Enrollment
2,609 students
22% women
5% underrepresented minorities

Degrees Awarded
660 Bachelor's degrees
860 Master's and MEng degrees
248 Ph.D., Sc.D., and professional engineering degrees

Faculty
220 Professors
77 Associate Professors
39 Assistant Professors

More information about the School of Engineering can be found online at http://web.mit.edu/engineering/.

Thomas L. Magnanti

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

The academic year 2000–01 was a year in which many of the plans and aspirations of the department materialized. The department returned to a newly refurbished Building 33. We continued our full-scale implementation of our strategic plan. The plan was a reaffirmation of our focus on the intellectually and industrially robust field of aerospace, coupled with a commitment to redirect the intellectual basis of the department to set and serve the directions of this industry. The new vision of the department which emerges is one which stands on three broad disciplinary bases: the traditional engine and airframe disciplines; the disciplines of real time system critical aerospace information engineering; and the disciplines required to architect and engineer extremely complex systems.

During AY2000–01, we moved into full scale development of our extensive reform of undergraduate education, which makes the conception, design, implementation, and operation of complex systems and products the context of engineering education. Major accomplishments this year included deployment of new teaching and learning technologies to the sophomore year, and the completion of our new learning laboratories, the Robert Seamans Laboratory and the Arthur and Linda Gelb Laboratory. We also began a major international alliance for educational reform with three universities in Sweden.

During the year we were joined by one new faculty, Charles Coleman in Human and Automation, with four more faculty hired and due to arrive in the next year. We have largely rebuilt our faculty from the retirees of 1996. We offered a new undergraduate program: Aerospace Engineering with Information Technology. Student enrollment at both the undergraduate and graduate level was on an upswing, and once again research activities increased markedly.

FUTURE PLANS

The department has now begun to move in its strategic direction and is implementing plans for new thrusts in Systems Engineering and Architecture, Information Engineering, the Engineering Context of Education, Research and Educational Program. The next year will focus on implementing the action plans, and forging relationships with industry necessary to accomplish our goals.

Table 1. 2000–01 Undergraduate Enrollment over the Last Ten Years

	90–91	91–92	92–93	93–94	94–95	95–96	96–97	97–98	98–99	99–00	00–01
Sophomore	76	61	33	36	36	30	46	40	48	59	68
Juniors	61	62	60	31	37	31	23	33	37	40	53
Seniors	104	73	66	66	38	37	29	24	35	37	45
Totals	241	196	159	133	111	98	98	97	120	136	166
% Women	23%	27%	28%	32%	31%	29%	26%	30%	33%	30%	32%
% Under Min.	20%	14%	12%	23%	19%	16%	18%	22%	15%	12%	21%

GRADUATE PROGRAM

A total of 300 applications were received for the fall 2000 term. Out of these, 126 were admitted, and 79 accepted the offer of admission. Enrollment for fall 2000 included 148 S.M., 0 EAA, 66 Doctoral, 10 M.Eng. degree candidates for a total of 224. Minority students totaled 12 (0 Doctoral., 12 S.M.). Total women students equaled 45 (13 Doctoral, 33 S.M., 1 M.Eng.). For the spring 2001 term we received 18 applications. We admitted 5, and 4 enrolled, including 1 woman. Zero minority applications were received. Enrollment for spring 2001 included 144 S.M., 63 Doctoral, and 6 M.Eng. for a total of 213. Total women: 46 (13 Doctoral; 33 S.M.). Total minority: 10 (10 S.M.; 0 M.Eng.).

Table 2. Degrees Awarded AY2000–01

Degrees	S.M.	EAA	Doctoral.	M.Eng.	Total
Summer (Sept. 00)	9	0	5	0	14
Fall (Feb. 01)	13	0	3	0	16
Spring (June 01)	41	0	5	3	49
Total	63	0	13	3	79

Table 3. Funding Sources Fall 2000 and Spring 2001

MIT Fellows/Tuition Awards	10
Outside Fellowships Staff Appointments	29
(RAs, Draper Fellows)	172
Teaching Assistants & Fellows	12
Engineering Internship Program	0
Other Types of Support	1
(Employer, Foreign, Self)	0
Total	224

FACULTY NOTES

Ian Waitz has been promoted to Full Professor, effective July 1, 2001.

Carlos Cesnik has been promoted to Associate Professor, effective July 1, 2001.

Eric Feron and Mark Spearing were granted tenure effective July 1, 2001. Professor Charles Coleman joined the faculty effective January 2001.

Professor Coleman received his B.S. from MIT and his M.S. and his Ph.D. from Berkeley. Professor Coleman's area of expertise is in automation systems. His appointment supports the department's thrust in "aerospace information engineering" particularly the focus area in Humans and Automation, where he will be working with John Hansman and Nancy Leveson on automation systems and software.

Robert Liebeck was appointed Professor of the Practice of Aerospace Engineering as of September 2000. Dr. Liebeck is a Senior Technical Fellow at Boeing and an expert in aerodynamic design. He is member of the National Academy of Engineering and heads a group working on advanced design for blended wing-body aircraft in the Boeing Phantom Works.

Steven Dorfman, former Vice Chair of Hughes Electronics spent the year as the Jerome Clark Hunsaker Visiting Professor of Engineering.

Arthur Muambara (Oxford University) and Stephen Ruffin (Georgia Tech) were in residence as Martin Luther King, Jr. Associate Professors.

Wesley Harris was on leave at Arizona State in the Barry Goldwater Chair of American Institutions. The first recipient of the chair was Barry Goldwater himself, and Wes is the first engineer to hold the position since its inauguration. Wes was also elected to the Board of Trustees of Princeton. Jack Kerrebrock received the 2000–2001 Undergraduate Teaching Award.

Dava Newman's book *Interactive Aerospace Engineering and Design* appeared in June 2001. The text includes integrated multimedia, the design process, and extensive coverage of space flight.

Richard Battin was the first recipient of the Tycho Brahe for fundamental innovations in the development and application of aerodynamics to mission planning and implementation of reliable guidance, navigation and control of manned and unmanned spacecraft.

Professor Emeritus Norman D. Ham was a recipient of the AHS Fellow Award. Professor Sheila Widnall received the REED Aeronautics medal from the AIAA.

FLUID DYNAMICS RESEARCH LABORATORY

The Fluid Dynamics Research Laboratory (FDRL) is active in research concerning computational, analytical and experimental issues in fluid dynamics and aerodynamics. Current research projects include: the development of a "distributed flow simulation environment" capability; aerodynamics of subsonic, transonic, and hypersonic vehicles; aeroelasticity; methods for developing low order aerodynamic models for multidisciplinary analysis; computational approaches to active flow control; the development of tools for aerodynamic analysis and design; distributed visualization; development of distributed fast equation solvers; and development of algorithms for assessing and quantifying numerical uncertainty.

INTERNATIONAL CENTER FOR AIR TRANSPORTATION

The objective of the International Center for Air Transportation (ICAT) is to improve the safety, efficiency and capacity of domestic and international air transportation and its infrastructure, utilizing information technology and systems analysis. The principle thrusts of ICAT over the past several years have been in advanced Air Traffic Management (ATM), understanding airline industry dynamics and in mitigating adverse environmental effects such as noise and aircraft emissions. The activities in this area have ranged from evaluations of future operational concepts for the U.S. National Airspace System; design of decision aids to improve airport departure performance; development of cockpit and controller alerting systems; evaluation of Collaborative Decision Making between ATC and airlines; evaluation of analytical models of ATM systems and conducting fundamental human performance studies of pilot and controller interactions. ICAT has continued to work in the areas of cognitive systems and decision aids for flight critical cockpit systems. This work includes advanced alerting systems, human understanding of advanced flight automation systems, development of critical software systems and other flight safety topics. ICAT is also a key participant in the Global Airline Industry Study supported by the Sloan Foundation.

LEAN SUSTAINMENT INITIATIVE

The mission of the Lean Sustainment Initiative (LSI) is to enable fundamental transformation of the U.S. commercial and military maintenance, repair, and overhaul (MRO) industries into a cost-effective, quality driven, timely, and responsive support system.

This year the LSI developed a universal framework by which the MRO of generic corporate assets may be defined, analyzed, synthesized, and transformed. This universal framework applies to MRO activities in aviation, land-based transportation, seaport and docks, airports, real estate, hospitals, and many other large complex corporate enterprises.

LSI established three research teams to focus on sustainment operations, business processes, and enterprise level MRO activities at U.S. Air Force depots. The sustainment operations team addressed the problem of insufficient parts and materials in U.S. Air Force depots. The business processes team investigated the unsatisfactory performance of forecasting models and methods employed by the U.S. Air Force to correctly define requirements. The enterprise level team continued its study of goals, objectives, and metrics that drive behavior and performance at the flight line; this study has produced a "metrics thermostats" for MRO operations at the flight line.

LSI delivered presentations based on LSI research at major national conferences held on the campus of Arizona State University, Massachusetts Institute of Technology, and Princeton University. It produced several Masters theses, white papers, and technical briefings, and expanded the stakeholder base to include two U.S. commercial aircraft MRO companies. LSI was described by the Commander, USAF Material Command before the House Armed Services Committee, 23 March 2001, as an undertaking to identify critical breakthroughs and change the paradigm of maintenance, repair, and overhaul support for the 21st century.

Future plans include expanding the stakeholder base to include national and international corporations and foundations and developing curricula based on LSI research findings and the LSI derived universal framework for MRO activities research.

CENTER FOR SPORTS INNOVATION

The second year of the Center for Sports Innovation (CSI) resulted in the launch of several new projects, as well as the continuation of successful programs from the first year.

The 2000–2001 academic-year saw 10 undergraduates complete their bachelor's thesis in CSI. Students were from both Aeronautics and Astronautics and Mechanical Engineering. Projects included the design of exercise equipment and triathlon shoes, and performance testing of bicycle, in-line skates and hockey padding. Additionally, sponsored projects included studies of ski boot performance and exercise equipment.

During IAP 2001, CSI again hosted the popular sports product development seminar series featuring speakers from Finish Lynx, L.L. Bean, New Balance, and Skis Dynastar.

CSI activities continue to generate interest in the popular press. The highlight of the year was an appearance on CNN International to discuss the effect of technology on sports.

WRIGHT BROTHERS WIND TUNNEL

The 2000–2001 academic year saw the continued support of the Aeronautic and Astronautics department in the academic utilization of the Wright Brothers Wind Tunnel (WBWT). Wind tunnel testing of a new F-16 model was the cornerstone of the 16.100 aerodynamics course. Student groups spend nearly 20 hours of test time at WBWT in the course of the semester. Laboratory time in WBWT was also part of Unified and 16.110. Additionally, four 16.621-16.622 projects utilized WBWT for testing during the academic year.

Commercial work at WBWT over the past year had ranged from testing the performance of miniature tactical and reconnaissance air-craft to testing high performance motorcycles.

Undergraduate Awards for 2000–2001

This year, the student chapter of the American Institute of Aeronautics and Astronautics (AIAA) presented the department's undergraduate teaching award to Professor Jack L. Kerrebrock, and the department's undergraduate advising award to Professor Earll M. Murman.

The Yngve Rausten Award was presented to David R. Smith, a sophomore from Folsom, CA, as the student who best exemplified the spirit of Yngve Raustein by his encouragement and support to other students as well as overcoming obstacles in the pursuit of his love for aerospace engineering.

The Andrew Morsa Memorial Award was awarded to Paul Eremenko, a senior from West Lafayette, IN, for the application of computers in combining wind-tunnel data, computational fluid dynamics, 6 dof dynamic models, and control theory to develop a pitch-rate controller designed to meet stringent uav performance requirements.

The Apollo Program Prize, awarded to an Aero-Astro student who conducts the best undergraduate research project on the topic of humans in space, was presented to Dana M. Forti, a senior from Tyngsboro, MA, and Shana L. Diez, a senior from Sugarland, TX, for their conception, design, and operation of a two-person human powered artificial gravity centrifuge.

The David J. Shapiro Memorial Award for designing, building and flying a high-speed electric-powered model aircraft in the 2001–2002 Design Competition of the AIAA/Cessna Aircraft, and the Office of Naval Research was presented to a team of eight students: graduate student Larry Baskett of Pleasanton, CA; seniors Bernard F. Ahyow of Irvine, CA, and Lawrence O. Pilkinton of Ogallala, NE; sophomores Daniel J. Benhammou of Colorado Springs, CO, Adam J. Diedrich of Petoskey, MI, Timothy D. Pigeon of Bridgewater, MA, Erik S. Stockham of Columbia, MO, and Caroline Twomey of Oconomowoc, WI.

The David J. Shapiro Memorial Award for designing, building and operating a radio-controlled micro air vehicle (MAV) to compete in the Arizona State University Micro Air Vehicle 2001 Competition was presented to Martin Jonikas, a freshman from Berkley, CA, on behalf of the Aero Astro Tech Model Aircrafters Club.

The Leaders for Manufacturing Prize was awarded to Bernard F. Ahyow and Nathan A. Doble, a senior from Shoreview, MN, for developing and validating a novel manufacturing technique for thin propellers with improved aerodynamic performance relative to conventional propellers.

The Pratt and Whitney Awards for outstanding achievement in the design, construction, execution and reporting of an undergraduate experimental project were presented to seniors Lisa Dang of Downey, CA, and Alan Y. Chen of Newtown, PA, for the characterization of JP-7 fuel as a micro-engine propellant, and to seniors Yassir Azziz of Casablanca, Morocco, and Mariya A. Ishutkina of Newton, MA, for the experimental verification of a new theory for aero-structural vibration suppression.

The James Means Memorial Award for Excellence in Space Systems Engineering was presented to Lisa Dang for her superb contributions to the class project—an innovative multi-aperture reconnaissance satellite. Her work epitomized the highest levels of excellence in space systems engineering.

The James Means Memorial Award for Excellence in Flight Vehicle Engineering was presented to Paul Eremenko for excellence and creativity in the systems level and technical design of a low noise-impact supersonic business jet.

The Admiral Luis De Florez Award for original thinking or ingenuity was presented to seniors Lisa Dang and Alan Y. Chen for developing an innovative method to measuring the temperature and heat transfer properties of JP-7 fuel using remote sensors.

The Henry Web Salisbury Award, established by the family and friends of Henry Salisbury, was presented to Noah Z. Warner, a senior from Petaluma, CA, for outstanding work in the completion of the undergraduate degree program in the Department of Aeronautics and Astronautics.

More information about the Aeronautics and Astronautics Department can be found online at http://web.mit.edu/aeroastro/www/.

Edward Crawley

DEPARTMENT OF CHEMICAL ENGINEERING

In the academic year 2000–2001, the department maintained its high productivity and visibility. We continued as number one amongst chemical engineering departments in the annual academic survey of the *US New and World Report*. We graduated 21 doctoral candidates together with 40 M.S. students, totaling 61 advanced degrees. The research dollar-volume of over $19 million was reached to support departmental research activities.

The department's undergraduate enrollment stands at 232 students with approximately 85 students per graduating class and the percentage of women now reaching 56 percent. A $3.4 million renovation to the entire sub-basement of Building 66 is underway in order to create a state-of-the-art undergraduate teaching laboratory ready for student use in the spring term of 2002.

The graduate student enrollment is stable at 206 students with 166 in the doctoral program and 40 master's students, most of whom are in the David H. Koch School of Chemical Engineering Practice. The class includes 73 foreign, 59 female and 32 minority students, of which 18 are Asian American. This year, we received 372 applications for our graduate program and offered admission to 89 students, with 49 accepting our offer.

Professor Alice P. Gast from Stanford University will join MIT in the fall of 2001 as Vice President for Research and Associate Provost for the Institute and as the Chemical Engineering Department's first holder of the Robert T. Haslam Professorship. This spring, Professor Gast won the election into the National Academy of Engineering for her research at the frontiers of the chemical physics of colloidal and polymer solutions, polymer adsorption and, most recently, proteins.

Professor Kenneth J. Beers joined the department as an Assistant Professor in July 2000 after completing a postdoctoral position at the Swiss Federal Institute of Technology (ETH) in Zurich. Professor Patrick S. Doyle began his appointment as an Assistant Professor in December 2000 following a postdoctoral appointment at the Institute Curie in Paris.

Professor Jackie Y. Ying was promoted to full Professor. Professor Paul I. Barton was promoted to Associate Professor with tenure. Both promotions are effective in July 2001.

Professor Karen K. Gleason assumed the role of Executive Officer in the Department as of July 2001, replacing Professor Charles L. Cooney. The department is extremely appreciative of the unprecedented set of building and renovation projects under Professor Cooney's leadership since 1995. Also effective July 2001, Professor Daniel Blankschtein becomes Graduate Officer and Professor Dane K. Wittrup will head Graduate Admissions, filling posts vacated by Professors Robert E. Cohen and Gregory Rutledge, respectively. Professors Cohen and Rutledge both provided dedicated leadership to these roles for the last several years.

Some noted changes in the department's administrative staff occurred. Suzanne Easterly became Academic Administrator, filling the opening created when Janet Fischer assumed a new role in the Provost's Office. Brett Groshong replaced Peter Maloof as Systems Analyst. David Crowley accepted the newly created position of Web Developer, a role that will interface with the Institute's OpenCourseWare initiative.

We are again proud of the faculty achievements this year and especially wish to note the following awards. Professor Robert A. Brown, currently the MIT Provost, was elected to the National Academy of Science (NAS), recognizing his many contributions to scientific research and leadership. Professor Douglas A. Lauffenberger was elected to both the National Academy of Engineering and the American Academy of Arts and Sciences. Professor Gregory Stephanopoulos received the R.H. Wilhelm Award in Chemical Reaction Engineering, sponsored by the American Institute of Chemical Engineers (AIChE). Professor Herbert H. Sawin was elected as a fellow in the American Vacuum Society. Professor Robert Langer received the Glaxo Wellcome International Achievement Award from the Royal Pharmaceutical Society of Great Britain. Professor Emeritus János Beér received the George Westinghouse Gold Medal form the American Society of Mechanical Engineers.

Robin Elices of the Administrative Services Office was recognized by MIT with a Financial Group Infinite Mile Award.

The DuPont-MIT Alliance (DMA) in Bio-Based Materials, established with the goal of catalyzing research and education at the biology/materials interface, began operation during this past year; with Professors Robert Cohen and Douglas Lauffenburger serving as MIT Associate Directors, along with Provost Robert Brown as MIT Director. The Department of Chemical Engineering is a prominent participant in DMA, with a number of faculty leading or involved in multi-investigator research projects. These faculty members include Robert Cohen, Linda Griffith, Paula Hammond, Alan Hatton, Klavs Jensen, Paul Laibinis, Robert Langer, Douglas Lauffenburger, Gregory Stephanopoulos, and Daniel Wang.

The Molecular Engineering of Biological and Chemical Systems (MEBCS) was initiated in 2001 as one of the five graduate programs under the Singapore-MIT Alliance, a joint educational and research enterprise between MIT, the National University of Singapore (NUS), and the Nanyang Technological University (NTU). Chaired by Professor

Jackie Ying (MIT) and Professor Miranda Yap (NUS), the MEBCS program offers two innovative courses of study that integrate a molecular-level understanding of biological and chemical phenomena with advances in process engineering for the life sciences and fine chemical industries. The professional master's (S.M.) degree program prepares graduates for the shaping and solving of complex problems through rigorous coursework, which presents advanced engineering concepts tying together multiple-length scales—molecular, microscopic and macroscopic—through a close coupling to biological, chemical and materials sciences. The S.M. degree offers students an opportunity to interact with the MIT faculty during the Immersion Program on the MIT campus. Additionally, S.M. students participate in two intensive six-week Industrial Immersion projects at international pharmaceuticals and fine chemicals companies. The Ph.D. degree program prepares graduates for advanced careers in industrial research and development centers, research institutes, and academia, with emphasis on synthesis skills, engineering design and interdisciplinary approaches. It includes advanced coursework and independent research with a full semester of study and research at MIT. Students conduct novel research under the joint supervision of MIT and Singapore faculty on structured fluids, surface functionalization, microstructure tailoring, and materials design in relation to fine chemicals and pharmaceuticals synthesis as well as on molecular and cellular aspects of biotechnology, genomics, bioinformatics, proteomics, drug design, and delivery that underlie advanced bioengineering.

UNDERGRADUATE EDUCATION

Table 1. Undergraduate Enrollment over the Last Eight Years

	93–94	94–95	95–96	96–97	97–98	98–99	99–00	00–01
Sophomores	115	108	118	87	97	88	71	67
Juniors	90	104	101	121	90	90	85	76
Seniors	84	100	103	110	130	94	103	89
Total	289	312	322	318	317	272	259	232

The undergraduate program remains strong with excellent students. We have completed a review of the undergraduate curriculum, which has resulted in the proposal of several significant changes. We will be introducing a new subject, 10.10 Introduction to Chemical Engineering, which will be the first proposed required subject for the major, as well as serving as a subject to introduce freshmen to Chemical Engineering. In addition, the Integrated Chemical Engineering (ICE) sequence in the senior year will be restructured to allow more time to consider the design process. Employment opportunities for our graduates remain strong across a wide variety of industries, including biotechnology, semiconductor fabrication and consulting, as well as the traditional chemical and petroleum industries.

Junior Desirée Ramirez received a Martin Luther King Leadership Award for her devotion to improving racial and cultural interaction within the MIT community. In addition, the Howard W. Johnson Award for the male senior athlete of the year was given to Stefan K. Bewley, a standout in both water polo and swimming.

GRADUATE EDUCATION

Table 2. Enrollment by Graduate Degrees over the Last Eight Years

	93–94	94–95	95–96	96–97	97–98	98–99	99–00	00–01
Master's	62	64	56	64	51	59	54	40
Doctoral	147	166	169	162	167	140	145	166
Total	209	230	225	226	218	199	199	206

The total for 2000–2001 includes 73 foreign students, 59 female students, and 32 minority students (not including Asian-Americans). Graduate admissions data suggest that graduate enrollment will remain in the low 200s for the foreseeable future.

Chemical Engineering graduate students, Chen Wang and Brian Stoll received Graduate Student Council Teaching Awards at the MIT Awards Convocation on May 14, 2001. The first prize for the MIT $50K Entrepreneurship Competition was made to Chemical Engineering students Edward S. Ahn and Darren D. Obrigkeit for their idea to develop and market a new technique for repairing bone injuries.

The department's new Ph.D. in Chemical Engineering Practice (Ph.D.C.E.P.) program welcomed its first entering group of five graduate students in September of 2000, jointly by Chemical Engineering and the Sloan School of Management. The program's integrated content includes core Chemical Engineering principles and practice, independent research, and a solid grounding in the principles of business and management. The five students, representing undergraduate institutions ranging from the Georgia Institute of Technology to the University of Tokyo, all successfully completed the department's core graduate curriculum, passed through the doctoral qualifying procedures and selected their doctoral thesis research topics. In the summer of 2001, PhDCEP students are attending the School of Chemical Engineering Practice, returning at the end of August to re-engage in their thesis research and to welcome the second class of Ph.D.C.E.P. students to the campus. A Ph.D.C.E.P. faculty steering committee, chaired by Bob Cohen with members Greg Rutledge, Alan Hatton and Charlie Cooney, has been set up to monitor the progress of students in this new doctoral program.

Twenty-eight students participated in the David H. Koch School of Chemical Engineering Practice program during the 2000–2001 sessions. Last summer, students attended the stations at Alkermes, Cambridge, MA; Mitsubishi Chemical Corporation in Mizushima, Japan; and GE Plastics in Mount Vernon, NY. In the fall, the operating stations were GE Plastics and M&M*Mars Incorporated in Hackettstown, NJ, while spring saw the students again at GE Plastics and Cargill. This summer, in addition to the Alkermes and Mitsubishi sites, students have been working on food processing projects at General Mills in Albuquerque, NM and Buffalo, NY. GE Plastics terminated as a permanent host station this spring, while Cargill plans to continue to run during spring semesters only. Dr. Paul Bryan continued as station director for the GE Plastics station and has been working with the General Mills group this summer. Dr. John Friedly directed the Cargill, Alkermes and Mars stations. Dr. Barry Johnston directed the station in Japan, assisted by Ms. Sonja Sharpe, in the summer of 2000. This summer, Mr. Brian Baynes assisted Dr. Bill Dalzell in the running of the Japan station. Professor T. Alan Hatton continues to direct the Practice School from Cambridge. Ms. Carol Phillips, the Practice School Administrative Secretary, retired due to health reasons at the end of June 2000 and was succeeded temporarily by Ms. Arline Benford, who then passed the baton on to Ms. Beth Tuths this past spring. It is with sadness that we report the passing of Ms. Phillips in November 2000 after a protracted bout with cancer.

FACULTY NOTES

Professor Robert Armstrong continued as Head of the Department of Chemical Engineering during the academic year 2000–2001. He was elected to the Governing Board of the Council for Chemical Research (CCR) and serves on the Program Committee for the Annual Meeting of CCR. He also serves on the External Advisory Board and Visiting Committee for the Department of Chemical Engineering at Georgia Institute of Technology. He gave a seminar at the University of Minnesota.

Professor Paul I. Barton was promoted to Associate Professor with tenure. He gave the Keynote Address at the International Symposium on Design, Operation and Control of Next Generation Chemical Plants (Process Systems Engineering, PSE Asia, 2000), Kyoto, Japan. He gave invited papers at the First Society for Industrial and Applied Mathematics (SIAM) Conference on Computational Science and Engineering, Washington D.C.; the Institute of Electrical and Electronics Engineers (IEEE) International Symposium on Computer Aided Control System Design, Anchorage, AK; and the Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting, San Antonio, TX. He gave invited lectures at the Rheinisch-Westfälische Technische Hochschule Aachen (RWTH-Aachen), Germany; Laboratoire des Sciences du Génie Chimique (CNRS-ENSIC), Nancy, France; and the Interdisciplinary Center for Scientific Computing, Heidelberg University, Germany. He joined the editorial board of *Chemical Engineering and Processing* and continued to serve as the AIChE's Group 10C Programming Coordinator. He served on the International Programming Committee for DYCOPS-6 (6th Symposium on Dynamics and Control of Process Systems).

Professor Daniel Blankschtein was a Keynote Speaker at the New England Chapter of the Society of Cosmetic Chemists, and an invited speaker at the CABOT Corporation Laser Quality Summit. He continues to serve on the Editorial Boards of *Current Opinion in Colloid and Interface Science* and Marcel Dekker's *Surfactant Science Series*. Professor Blankschtein was recently appointed Graduate Officer in the Department of Chemical Engineering.

Professor Howard Brenner received the 2001 Caribbean Congress of Fluid Mechanics award at their triennial meeting at Simón Bolívar University in Caracas, Venezuela, in addition to receiving a Distinguished Alumni Citation from the Pratt Institute, his undergraduate alma mater. He served as a member of the Chemical Engineering Peer Review Committee of the National Academy of Engineering. During the year, he presented invited seminars at the Universities of Illinois (both Chicago Circle and Champaign-Urbana), Wisconsin, Florida, and Alabama, as well as at the Illinois Institute of Technology and Simón Bolívar University. Additionally, he presented or co-presented papers at meetings of the American Institute of Chemical Engineers, the American Physical Society Fluid Dynamics Division, the Society of Rheology, and the American Chemical Society Division of Colloid Science, as well as at the International Workshop on Miscible Fluids in Paris.

Professor Robert A. Brown continued serving as Provost at MIT, a position he has held since 1998. He was Plenary Lecturer at the American Association of Crystal Growth Meeting (AACG-12) in August 2000 and at the International Workshop on Crystal Growth Modeling in October 2000. Professor Brown continued to serve as Executive Editor of the *Journal of Chemical Engineering Science* and as a member of the National Research Council decadal study on the Frontiers in Chemistry and Chemical Engineering. Among other forms of service, Professor Brown continued to serve on the International Academic Advisory Panel (IAAP) to the Government of Singapore and as Director of the DuPont-MIT Alliance at MIT. He was elected to the National Academy of Science in spring of 2001.

Professor Charles L. Cooney continued to serve as the Executive Officer of the Department with plans to step down as of June 30, 2001. He is on the Board of the MIT Community Services Fund. He is the Co-Director of the Consortium for Advanced Manufacturing of Pharmaceuticals (CAMP), an industry consortium jointly run with Purdue University to support research on pharmaceutical manufacturing and continues as Co-Director of the Program on the Pharmaceutical Industry (POPI), a joint program between the Schools of Engineering, Science and Management. He has continued his participation on the external review committee for the Department of Chemical

Engineering of the University of Cambridge and continues to co-chair an assessment team for technopreneurship programs in Singapore.

Professor William M. Deen and his laboratory continued its investigations in the areas of hindered transport in fibrous media, water and macromolecule filtration in kidney capillaries, and physico-chemical aspects of nitric oxide toxicity and carcinogenicity.

Professor Patrick S. Doyle joined the faculty in December 2000. He was invited to speak about his research in the area of microfluidics at the SmallTalk conference and MipTech Lab Automation conference, where he was awarded the 2001 PolyPops award for the best paper presented. Professor Doyle was also an invited lecturer at Harvard and DuPont.

Professor Karen K. Gleason will begin serving as the Chemical Engineering Department's Executive Officer in July 2001. Her primary focus in this position will be to improve the undergraduate experience for Course X majors. Professor Gleason's research group continues to invent and optimize new vapor deposition methods for organic coatings, which resulted in three US patent awards this past year. She was the Van Ness Lecturer at the Rensselaer Polytechnic Institute, and also an invited lecturer at the Universities of Wisconsin and Arizona, and at a number of international conferences, including the Toyko Electron Advanced Technology Forum (Japan), Fluorine in Coatings Conference (Belgium), and Colloquium on Plasma Processes (France). Several of her MIT swimming records set more than twenty years ago, fell this year. However, one still remains uncontested.

Professor William H. Green gave the Keynote Lecture at the fifth International Conference on Chemical Kinetics. He chaired a session on Combustion Reaction Engineering at the 2000 AIChE National Meeting, and was an invited lecturer at the University of Minnesota, the Department of Energy (DOE) Combustion Conference, the eighth International Conference on Chemical Reaction Engineering, and the first MIT Conference on Computational Fluid and Solid Mechanics. He was invited to join the Editorial Advisory Board of the *International Journal of Chemical Kinetics*, and to publish special invited articles reviewing his recent research in that journal and in *Theoretical Chemistry Accounts*.

Professor Linda Griffith continues to serve as the Principal Investigator on a Defense Advanced Research Projects Agency (DARPA) project to develop tissue-based sensors for biological warfare agents, collaborating with R. Kamm, D. Schauer, J. Sherley, and S. Tannenbaum at MIT; J. Vacanti and R. Lee at the Harvard Medical School (HMS); and J. Wands at Brown University. This project has been further expanded into a DMA-supported effort to develop physiological models for effects of environmental agents. A broad patent on the technology has been granted and MIT is in licensing discussions. She also continues to work in the area of new polymers for tissue engineering and cell biology. She chaired a National Institutes of Health/National Science Foundation (NIH/NSF) workshop on training and education in bioengineering, medical engineering and bioinformatics and gave a plenary lecture at the NIH Conference on Reparative Medicine. She gave several invited talks at conferences, other universities, and government panels. At MIT, she continues to serve as the Associate Director of Education for the Biotechnology Process Engineering Center (BPEC), the faculty advisor for the Biomedical Engineering Society, and as head of the Biotech Student Leadership Council.

Professor Paula T. Hammond was recently elected Vice Chair of the Polymer Area Programming Committee for the American Institute of Chemical Engineering. She was an invited lecturer at the International Pacifichem and Polymillenial meetings held in Hawaii in December 2000; these meetings were co-hosted by the American Chemical Society and the chemical societies of Japan and countries in the Pacific Rim. She was also an invited lecturer at several international and national meetings, companies, and universities, including the University of California at Santa Barbara, the University of Michigan, the University of Toronto and the German-American Frontiers of Polymer Science Meeting. Dr. Hammond served as American Chemical Society (ACS) Symposium Chair for "Macromolecular Self Assembly at Surfaces and Interfaces" at the April 2001 ACS National Meeting. Professor Hammond was recently appointed the Joseph R. Mares Associate Professor Career Development Chair effective July 1, 2001.

Professor T. Alan Hatton continued to serve as Director of the School of Chemical Engineering Practice at MIT. Keynote talks were given at the International Association of Colloid and Interface Scientists (IACIS) 2000 (Bristol, UK) and ACS National (Washington DC) and invited presentations at Particles 2001 (Orlando, FL) and ACS National (San Diego, CA) Meetings, and at the joint Beijing AIChE/China University Chemical Engineering (CUChE) meeting. Other invited presentations were given at Tianjin University (China), Merck (West Point, PA), and the California Institute of Technology, in addition to many other presentations at national and international meetings. Professor Hatton played a significant role in establishing the "Molecular Engineering of Biological and Chemical Systems" program under the Singapore-MIT Alliance, and is spearheading the joint Cambridge University/MIT Practice School program under the Cambridge-MIT Institute initiative. He serves on the editorial boards of a number of scientific journals.

Professor Jack B. Howard continues to serve as Director of the Center on Airborne Organics involving MIT, the California Institute of Technology, and the New Jersey Institute of Technology. He continues to do collaborative research with Professor J.B. Vander Sande (MSE) on flame synthesized fullerenic carbon materials. He gave invited lectures at University of Michigan on ultrafine atmospheric particles from combustion sources; and at *Technische*

Universität Darmstadt in Darmstadt, Germany; and *Université de Haute Alsace* in Mulhouse, France on combustion synthesis of fullerenes.

Professor Klavs F. Jensen received the 2000 R.H. Wilhelm Award for reaction engineering from the American Institute of Chemical Engineers. Professor Jensen continued research on multiscale modeling of reactive processes for thin film deposition, microfabricated chemical systems for synthesis and analysis (in collaboration with Martin A. Schmidt [EECS]), novel quantum dot composite materials for optical devices (in collaboration research with M. G. Bawendi [Chemistry]). He gave several invited presentations on multiscale modeling of thin film deposition and on microchemical systems at the national and international conferences, including Foundations of Molecular Modeling and Simulation, International Symposium on Chemical Reaction Engineering, Krakow, Poland; First SIAM Conference on Computational Science and Engineering, September 2000, Washington, DC; and at universities. He continued to serve on the Defense Science Research Council and co-chaired the National Research Councils workshop on future chemical and chemical engineering opportunities in materials chemistry. He was elected to the editorial board of the Royal Chemical Society's new journal, *Lab on a Chip*, and to the programming committee for micrototal analysis systems (laboratory on a chip) annual conferences.

Professor Paul E. Laibinis was an invited lecturer at the University of Washington, Zhejiang University, 3M, IBM, Agilent, Millipore, and various other industrial laboratories. He gave invited presentations at the Gordon Research Conference on Chemistry at Interfaces (New Hampshire), the 3rd Joint China/USA Chemical Engineering Conference (Beijing), and the 2nd Chemical Engineering Conference for Collaborative Research in Eastern Mediterranean (Ankarra). In 2001, Professor Laibinis was appointed to the editorial boards of the journals *Langmuir* and *Sensors* and to the Victor K. LaMer Award Committee of the Colloid and Surface Chemistry Division of the American Chemical Society. He was a member of the National Research Council's Committee on Opportunities in Biotechnology for the US Army and served as Chair of a departmental committee on Graduate Curriculum that provided a substantial revision to the course requirements for doctoral students, to begin in fall 2001. Professor Laibinis is also a Faculty Fellow in the new Singapore-MIT Alliance Program on the Molecular Engineering of Biological and Chemical Systems.

Professor Robert Langer received a number of awards including the Glaxo Wellcome International Achievement Award (Royal Pharmaceutical Society of Great Britain), Millennial Pharmaceutical Scientist Award (Millennial World Congress of Pharmaceutical Sciences), First Pierre Galletti Award (American Institute of Medicine and Biological Engineering), the Wallace Carothers Award (American Chemical Society) and an honorary doctorate from the Catholic University of Louvain, Belgium. Dr. Langer has also been honored as the Herman Beerman Lecturer (Society for Investigative Dermatology), the Millennial Lecturer (University of Liverpool), the Bayer Lecturer (University of Pittsburgh), the Bayer-Stein Honorary Lecturer (University of Massachusetts at Amherst), the William G. Lowrie Lectureship (Ohio State University), the Frank T. Gucker Lecturer (Indiana University) and the First Patten Distinguished Lectureship (University of Colorado at Boulder).

Professor Douglas A. Lauffenburger was elected this past year to membership in the National Academy of Engineering and the American Academy of Arts and Sciences. On the MIT campus, he continues as co-director of the Division of Bioengineering and Environmental Health, Director of the Biotechnology Process Engineering Center, and associate director of the MIT-DuPont Alliance in Bio-Based Materials. On the national level, he is serving on the Advisory Council for the National Institute of General Medical Sciences, and this current year is Chair of the College of Fellows of the American Institute of Medical and Biological Engineering.

Professor Gregory C. Rutledge delivered a series of invited lectures in the fall of 2000 as the H.A. Morton Distinguished Visiting Professor of the Department of Polymer Science at the University of Akron, one of the leading institutes of polymer science and engineering in the country. He also presented invited or Keynote Lectures at the University of Pisa, Suranaree University (Thailand), the Institute for Mathematics and Its Applications (University of Minnesota), Polymer 2001 (a joint meeting of the Royal Society of Chemistry, the Institute of Materials and the Institute of Physics, Bath, UK), the Fiber Society (Raleigh, NC) and the 4th International Discussion Meeting on Relaxations in Complex Systems (Crete, Greece). He taught professional courses on computer modeling of polymers for both the American Chemical Society and the American Physical Society in 2000–2001. He has continued to serve as Chairman of the Chemical Engineering Department Graduate Admissions Committee and in addition assumed responsibilities as the director of the Program in Polymer Science and Technology at MIT. He also serves on the editorial boards of *Polymer* and of *Computational and Theoretical Polymer Science.*

Professor Kenneth A. Smith has continued his research on the roles of fluid mechanics and transport phenomena in a number of contexts. These include use of the supercritical water oxidation process for destruction of organic wastes (jointly with Professor J. W. Tester) and the dynamics of micellar self-assembly (jointly with Professor T. A. Hatton). He is also engaged in the development of an instrument that can determine the size-segregated chemical composition of an aerosol and do so in real time. During the spring, Professor Smith was on sabbatical at the University of Cambridge, where he was a visiting faculty member in the Department of Chemical Engineering and an Overseas Fellow at Churchill College.

Professor George Stephanopoulos assumes the position of Chief Technology Officer for the Mitsubishi Chemical Corporation's (MCC) group of companies as of July 1, 2001, taking a leave of absence from MIT. During the period

from September 2000 to July 2001, he presented the following lectures on the reformation of MCC's R&D organization: "R&D and Intellectual Properties Management under Integrated Strategies" at the *International Technology Transfer Symposium* in Tokyo, January 26, 2001; "Is there a Need for a New Process Systems Engineering?", *Division of Process Systems Engineering*, Japanese Society of Chemical Engineers, February 9, 2001 in Tokyo; and "From a Process-Centered to a Product-Centered Chemical Company: The Strategic Imperatives of the MCC-Group and its Implications," *Technological Management in Polymer Industries* (Koubunshi Douykai), in Tokyo, April 24, 2000. The short summer course taught by Professor Stephanopoulos, *Bioinformatics: Principles, Methods, and Applications,* was again offered at MIT in the summer of 2001.

Professor Gregory Stephanopoulos continued his educational and research activity in bioinformatics and metabolic engineering. This program aims at the integration of genomic information and physiological data for the elucidation of cell physiology leading to the rational modification and analysis of cell metabolism for medical and industrial applications. This program comprises a research component as well as courses on metabolic engineering and bioinformatics. Professor Stephanopoulos continued as co-editor of the journal *Metabolic Engineering,* published by Academic Press. In addition, he serves on the editorial boards of 7 other scientific journals. He delivered plenary lectures at the UK Biotechnology and Biological Sciences Research Council (BBSRC) and The Engineering and Physical Sciences Research Council (EPSRC) meetings in London (May and September, 2000), the European Symposium on Biochemical Engineering Science (Copenhagen, September 2000), the third Metabolic Engineering Conference (Colorado Springs, October, 2000), the Annual ACS meeting in San Diego (April 2001), the annual ASM meeting in Orlando (May 2001), and the Computer Aided Process Engineering ESCAPE 11 Conference in Copenhagen (May 2001). Professor Stephanopoulos was also recognized for his contributions to biotechnology by the Marvin J. Johnson Award of the Biotechnology Division of ACS (April 2001). For his research and educational activity in promoting the field of Metabolic Reaction Engineering, he won the 2001 Wilhelm Award of the American Institute of Chemical Engineers. In May 2001, he was elected member of the International Faculty of the Technical University of Denmark.

Professor Jefferson W. Tester continued as the Director of the Energy Laboratory throughout the academic year 2000–2001. He served as Chair of the National Advisory Council of the DOE's National Renewable Energy Laboratory and served as a member of the National Research Council's committee evaluating the DOE's Office of Power Technologies R&D programs. Professor Tester also continued as a member of the advisory group for the Paul Scherrer Institute, which is part of the Swiss Federal Institutes of Technology as well as his appointment to former Governor Cellucci's Advisory Council for the Massachusetts Renewable Energy Trust Fund. He was appointed to serve as a member of the Idaho National Engineering and Environmental Laboratory's (INEEL) Division Review Committee on Nuclear and Energy Systems. Last year, he gave invited lectures at Washington State University, the University of Idaho, and ETH Zurich. He was also the recipient of the Department's Outstanding Faculty Award.

Professor Bernhardt L. Trout was named the Henry C. and Grace Doherty Professor in Ocean Utilization for his work on clathrate-hydrates. He has given invited talks at the National University of Singapore and Georgia Institute of Technology, in addition to AIChE and ACS. Funding for his projects on chemical and process design via molecular understanding is provided by the National Science Foundation (NSF), the Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), Amgen, Inc., and Ford Motor Company.

Professor Daniel I. C. Wang was awarded an honorary doctoral degree in engineering from the Hong Kong University of Science and Technology in November 2000. He was also awarded in October 2000 the Temasek Professorship for three years at the National University of Singapore, where he will spend time at the Bioprocessing Technology Centre to assist and collaborate in a number of research projects in the biomedical sciences. Professor Wang was the dinner speaker in January 2001 at the MIT Club of Singapore, where he addressed MIT alumni and SMA students and faculty on the future developments in biomedical sciences. He was a Keynote Lecturer at the Biochemical Engineering Conference in Sonoma, California in June 2001. He acted as the Chairman for the past year on a project on the "Standardization and Certification of Chinese Medicine," coordinating the activities of four Hong Kong universities. He is a member of the Advisory Committee for the Marine Biotechnology Center at the University of Hawaii and the University of California, Berkeley. Lastly, he has been appointed on the search committee for the Director of the Institute of Chemical Sciences in Singapore.

Professor Jackie Y. Ying was the recipient of the 2000 AIChE Allan P. Colburn Award for excellence in publications. She delivered twenty-one invited lectures at various international conferences and national meetings during the past year, including a plenary lecture at the third World-Wide Symposium on Inorganic Chemistry in Taiwan and a Keynote Lecture at the International Conference on Materials for Advanced Technologies in Singapore. She served as the co-organizer of the American Ceramic Society Symposium on Chemical Performance of Ceramics. Professor Ying was an invited seminar speaker at the University of Texas, Polytechnic University, National University of Singapore, Tulane University, North Carolina State University, Northeastern University, and the City College of New York. She was recently appointed to the editorial boards of *Applied Catalysis A, Acta Materialia and Scripta Materialia,* and serves on the editorial boards of six other journals/book series. Professor Ying is a Director of the AIChE Materials Engineering and Sciences Division, and an executive committee member of the American Chemical Society Colloid and Surface Chemistry Division. She Chairs the Singapore-MIT Alliance Program on Molecular Engineering of Biological and Chemical Systems.

RESEARCH HIGHLIGHTS

Engineering Bioseparations in Microfluidics Devices (Professor Patrick S. Doyle)

Biological assays routinely call for the separation of proteins, DNA, and cells. The demand to perform these assays faster and with smaller sample volumes is rapidly spawning new developments in microfluidic and lab-on-a-chip devices. Professor Doyle's group has been working with Dr. Viovy at the Institut Curie to develop novel ways to rapidly separate large DNA using custom 'obstacle courses' as a sieving medium in lab-on-chip devices. The obstacle course is constructed from superparamagnetic colloids which self-assemble into a regular, rigid matrix when a magnetic field is applied. The matrix resembles a 2-dimensional array of posts through which the DNA are driven with an electric field. In contrast to standard polymer gel matrices, the colloidal arrays can have extremely large and homogenous pores (~1-20 μm), which is advantageous for separating large DNA. Experiments have shown that separations are an order of magnitude faster than standard techniques with these new matrices. The Doyle group has also been studying DNA separations at the single molecule level using fluorescence video-microscopy. By watching and analyzing how the molecules collide and slip past obstacles they hope to develop mechanistic theories, which can then be used to rationally design improved obstacle courses. The Doyle group has also begun to study the self-assembly of the superparamagnetic colloids themselves. The colloids are confined in channels that are of comparable size to the bead diameter. In such confined geometries the self-assembly process is extremely sensitive to channel geometry, surface topology and magnetic field history. The aim of this work is to be able to guide the self-assembly process to create *tunable* matrices for microfluidics applications.

Modeling, Simulation and Optimization of Process Dynamics (Professor Paul I. Barton)

Chemical and biological manufacturing processes are large and complex systems, regardless of the actual physical scale (e.g., oil refineries, micro power generation systems, biological cells). Understanding and manipulation of time dependent (or dynamic) phenomena are crucial to the engineering of such systems, and has impacts on process efficiency, process economics, process safety and environmental performance. The unifying theme of research in Professor Barton's laboratory is the study of such large-scale dynamic systems.

The chemical processing industries make extensive use of general-purpose mathematical modeling software that supports the formulation, debugging and numerical solution of large-scale dynamic models. The software systems ABACUSS II (Advanced Modeling Environment and Embedded Simulator) and DAEPACK (Differential-Algebraic Equation Package), under development in Professor Barton's laboratory, represent the state-of-the-art in this technology, implementing advances in the areas of problem representation, software design, and numerical algorithms.

Important problems in process operations include the design and optimization of major process transients such as start-up, shut-down, and changeovers, the design and verification of automatic safety systems for abnormal situation management, the interaction between these issues and plant/equipment design, and the design of inherently dynamic systems such as batch processes and periodic processes. In recent years, there has been a growing awareness that process behavior during such operational transients experiences significant discrete aspects superimposed on the underlying continuous dynamics governed by conservation principles. These discontinuities (triggered by events) may be caused by control actions and/or disturbances (e.g., starting/stopping pumps, the action of an interlock system, equipment failures, etc.), or caused by changes in the physical regime (e.g., thermodynamic phase changes, changes in the flow regime, irregularities in the geometry of vessels, etc.). A natural detailed modeling framework for such situations is that of hybrid (discrete/continuous) dynamic systems. Research in Professor Barton's laboratory has pioneered the development of theory and numerical methods for hybrid dynamic systems. These include contributions to the modeling, simulation, sensitivity analysis, and optimization of hybrid dynamic systems. For example, these advances demonstrate that a start-up procedure may be designed automatically by formulating the problem as a hybrid dynamic optimization.

The batch mode of process operation is experiencing a renaissance due to the increasing importance of the pharmaceutical, biochemical, and advanced materials industries. Batch processes are ideal for the flexible manufacturing of multiple products with small production volumes, and are, thus, favored by these high-technology industries. Batch processes are inherently dynamic systems that do not have a steady-state; instead, they are forced by sequences of discrete control actions through their operational cycle. Professor Barton's laboratory has pioneered the development of detailed dynamic model-based techniques for the conceptual and detailed design of batch processes. Another thrust of research has focused on environmental issues in the design of pharmaceutical processes, using thermodynamic insights to develop processes that have highly integrated solvent recovery and recycling. This thrust has also motivated a number of contributions in the study of batch distillation of azeotropic mixtures (an azeotropic mixture does not change composition on boiling, which is a problem for separation via distillation because the intention is to exploit composition changes on boiling). For instance, we have invented novel batch distillation processes for azeotropic mixtures that can be applied on a small scale in a flexible manufacturing environment.

Increasingly, engineering problems in design and operations are being posed as formal optimization (or mathematical programming) problems. This has the advantage that, if a suitable algorithm is available, then an optimal design or operating policy may be found automatically, and often very non-intuitive solutions are discovered that improve the performance of the system significantly. Integer (binary) variables are often introduced to represent the choice of whether or not an element is to be included in the final design, or to represent the sequencing of events in an operational problem. The global solution of mixed-integer nonlinear optimization

problems where the participating functions are nonconvex has been an unresolved problem in the literature until very recently, and work in Professor Barton's group has been amongst the first to develop suitable algorithms. Current work is now extending these advances to dynamic optimization problems that involve integer decisions.

DEPARTMENTAL AWARDS

The Annual Awards Ceremony for the Department of Chemical Engineering was held on Monday, May 14, 2001 in Gilliland Auditorium. Professor and Department Head, Robert C. Armstrong, presided. The following are awards that were presented at the ceremony.

In collaboration with the Student Financial Aid Office, the James E. Cunningham '57 Scholarship was awarded to Tomoko Iida, a junior from Chiba, Japan and the John H. Dessauer Scholarship was awarded to senior, Deepa Patel, from Katy, Texas.

Merck Fellowships were acknowledged for two sophomore recipients: Bukola Aina from Philadelphia, PA and David Jackson from Spring, TX.

The recipient of the Dow Chemical Company Outstanding Junior Award was Lara Hawrylchak from Altamont, NY for her balanced record of achievement in academics and campus professional and social organizations, as well as work experience.

The Robert Haslam Cup was awarded to Christina Wilbert. She is a senior from Grand Rapids, MI and was recognized for outstanding professional promise in Chemical Engineering.

The Roger de Friez Hunneman Prize is the oldest in the Department and is given to an undergraduate for outstanding scholarship and research. This year, the award went to Philip Osafo-Kwaako from Korle-Bu, Accra, Ghana.

The Edward W. Merrill Outstanding Teaching Assistant Award was presented to Yonathan Thio, a graduate student from Purwokerto, Indonesia for his work with 10.213 in the fall. A second place award went to Vibha Srinivasan from New Delhi, India who was a Teaching Assistant for 10.32.

Every Monday, two graduate students present the progress of their research to be evaluated by their peers. Two graduate students were recognized for giving outstanding seminars. This year, recognition went to David Matheu, from Princeton, IL for his seminar during the fall term, and Suniti Moudgil from Gainesville, FL for her seminar during the spring term.

The Chemical Engineering Special Service Awards were given to Graduate Student Council (GSC) presidents John Locke from Loveland, CO and Patricia Sullivan from Canonsburg, PA. The current AIChE president, Princess Imoukhuede from Matteson, IL also received a Special Service Award.

The Chemical Engineering "Rock" Award for outstanding athletics, as voted by the graduate students of the Department went to Paul Ayers, from Cape Town, South Africa, for his active participation in a variety of intramural sports.

The Outstanding Employee Award was presented to Linda Mousseau, an administrative assistant for Professors Jackie Ying and Kenneth Smith, for her exceptional dedication to not only these professors but to the department as well.

The Outstanding Faculty Award from the graduate students went to Professor Jefferson Tester. The undergraduate students presented the Outstanding Faculty Award to Professor Michael Mohr.

Nominations for the Individual Accomplishment Citation were requested in the month of April and the recipient of the citation was Constance Beal. She was praised for her dedication to Professor Robert Langer's lab, and her huge contribution to the Network of Educators in Science and Technology (NEST) over the years.

Finally, three graduating seniors from the Department, Murat E. Kara, Tamara N. Oei, and Philip Osafo-Kwaako, were recognized for their nominations into the Phi Beta Kappa Society.

More information about the Chemical Engineering Department can be found online at http://web.mit.edu/cheme/.

Robert C. Armstrong, Karen K. Gleason

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

In its third revision since 1993, the Strategic Plan of Civil and Environmental Engineering (CEE) re-affirms three core areas of endeavor: the built environment, the natural environment, and information-engineering systems. We are committed to:

- Excelling in undergraduate education;
- Exploring new programs in graduate education with an appropriate balance between masters, including the M.Eng., and doctoral degrees;
- Developing new research in the following areas: development and sustainability; integration of infrastructure science and information technology; integration of environmental science, engineering design, advanced technologies, and synthesis tools;
- Facilitating interactions among the faculty and research staff required to pursue our thrust areas;
- Building strong ties between the department and private-public sector and exploit information technologies for the delivery of educational products; and
- Promoting diversity in faculty, students and staff.

We set seven goals:

- Aligning undergraduate and graduate programs with thrust areas: development and sustainability, information technology, system design and integration, and physical infrastructure;
- Mobilizing existing and develop new resources for research;
- Advancing the Masters in Engineering as a first professional degree;
- Launching new research and education initiatives with a system-wide view of engineering in collaboration with the Engineering Systems Division;
- Implementing a creative resource development campaign;
- Unifying the department in an environmentally friendly new building; and
- Continuing and strengthening our efforts to hire women and minorities to faculty ranks.

On March 19–21, 2000, we hosted the New Millennium Colloquium on the Future of Civil and Environmental Engineering in order to seek input and ideas as well as to present our own plans. Last June we reported on the findings of the Colloquium. Since then, we have distributed the proceedings via electronic media and have enjoyed the satisfaction of observing its positive impact on the profession.

In the following we summarize particular activities, in education and research, that have resulted from our planning effort as well as the colloquium.

UNDERGRADUATE EDUCATION

We have been concerned with undergraduate enrollment and have worked extremely hard to make our programs more attractive. We want to become the best and the most welcoming department at MIT. Last year, we outlined our strategy, spearheaded by major curriculum changes and increased outreach.

Our sophomore enrollment for the coming year, so far, shows that we are holding our own and have reversed, for two years in a row, the major enrollment drop that shows in next year's junior class. Presently, we have 23 sophomores, 18 juniors, and 28 seniors. We are confident that hard work will continue to pay and that we can operate successfully even in an unfavorable institutional and national environment.

In response to our goals, the undergraduate degrees are now very aligned with our educational philosophy and thrust areas. This was the graduating year for the first students operating under the new curriculum. We have developed the elements of a new Information Technology and Computation undergraduate program that is being discussed with others at the Institute in order to define an implementation strategy within CEE or, most probably, in collaboration with others. Our Master of Engineering program is increasingly attracting our own graduates, in consonance with our goal of making it the first professional degree, with a seamless transition from the undergraduate experience.

We have instituted a very successful program of IAP travel-study for undergraduates. Last year, some of the class went to do environmental field work in Hawaii and some went to Puerto Rico to study the San Juan subway system. This concept is being expanded and formalized further. We have been successful in attracting funding, including

resources for its extension to the freshmen year. Ms. Sheila Frankel, Research Associate and Lecturer, has been instrumental in this activity.

Our successful Summer Internship Program continues. This year we placed our 26 students in relevant summer employment. The program is being reviewed and expanded and its success has played a major role in the School of Engineering move to create a similar school-wide initiative.

Professors Culligan and Whittle have developed the guidelines for undergraduate exchanges with Cambridge University within the Cambridge-MIT Initiative (CMI) program. One of our undergraduates is part of the first batch of MIT students going to Cambridge next year.

GRADUATE EDUCATION

Our graduate program continues to thrive. The Master of Engineering (M.Eng.) program graduated its sixth and largest class of 62. A new business plan was prepared and approved and steps have been taken to improve operations and maintain quality, including a reduction of the number of admitted students and hence the size of the incoming class.

Travel-study has also become an integral part of M.Eng. This past year, students worked and traveled to places like Haiti, Nepal, London, Lebanon, and Turkey. The experiences have been worthwhile.

We were successful with a proposal to work within the CMI program to create an M.Phil. program in Cambridge, patterned after our M.Eng. and dealing with environmental and sustainability.

Last year, we had 289 graduate students. The Master's degree (M.S. or M.Eng.) remains a major product and attraction with 188 students. The doctoral programs were nevertheless healthy with 101 students.

We had a successful admission cycle. We received a total of 4153 inquiries compared to 3608 last year. These translated to 549 applicants (590 last year). The proportion of U.S. applicants was 26 percent. This is the department's, and MIT's, biggest concern. Some 51percent of applicants were offered admission and 129 have accepted the offer. Of these, 58 have received financial aid in the form of fellowships or research assistantships. Please note that M.Eng. students cannot receive research assistantships. Very few of them receive half-tuition fellowships. These restrictions are by design.

FACULTY NOTES

After completing a nine-year term, Professor Rafael Bras has stepped down as head of the Department of Civil and Environmental Engineering. He was elected to the National Academy of Engineering, and received a Giants of Science Award (Quality Education for Minorities). He is working with Professor Chisholm to spearhead the MIT Earth Systems Initiative.

Under the aegis of the Cambridge-MIT Initiative, Eric Adams is initiating a 4-year project to help develop a professional masters degree program in Environmental Engineering and Sustainable Development at Cambridge University.

Professor Cynthia Barnhart is an Associate Editor for *Transportation Science* in the area of Network Design and Network Modeling (1993–2000). She was awarded "Best Research Paper" for "Composite Variables for Service Network Design," with Armacost, A., and Ware, K.

Professor Oral Buyukozturk gave the keynote lecture on "Nondestructive Evaluation of Structures" at the International Conference on High Performance Materials, held in Hong Kong, December 10–15, 2000.

Professor Sallie Chisholm is chairing the search committee for the next department head. At the same time, she is also spearheading the Earth Systems Initiative. She spoke in November 2000 at the Carnegie Institution in Washington, on "The Invisible Forest: Phytoplankton and Climate" as part of the Capitol Science Lecture Series.

Professor Patricia Culligan delivered a keynote lecture on her work at an international symposium held in La Baule, France. In addition, she was appointed to the editorial board of two journals in her field. With Professor Heidi Nepf, Dr. Culligan also continues to develop educational programs on the environment for high school students.

Professor Herbert Einstein is Principal Investigator of an I-Campus project. He delivered the keynote lecture on Uncertainties in Landslide Analysis, at the United Engineering Foundation (UEF) Conference on Landslides.

Professor Fatih Eltahir was awarded the Kuwait Prize in ceremony hosted by the Emir of Kuwait in November of 2000, and delivered the keynote lecture. He also joined the Editorial Board for Advances in Water Resources.

Professor Dara Entekhabi was named Editor of the American Meteorological Society's Journal of Hydrometeorology, and Chair of the National Research Council's Committee on Hydrologic Science.

Professor Steven Lerman finished his term as Chair of the MIT Faculty this year and served on the Carnegie Mellon University Advisory Board for their Computing Services group.

Professor Ole Madsen was awarded the American Society of Civil Engineers (ASCE) "2001 International Coastal Engineering Award."

Professor Dennis McLaughlin was elected Deputy Editor of Water Resource Research (responsible for resource economics, policy, and systems).

The Army Corps' Chief of Engineers, Lieutenant General Robert Flowers, awarded Professor Fred Moavenzadeh the de Fleruy Medal for his service to the Army Corps of Engineers.

Professor Heidi Nepf was named a MacVicar Fellow this year. She served as Co-Director of Education Outreach with Professor Patricia Culligan.

Dr. Rory O'Connor has just joined the Department as Assistant Professor in the Engineering Systems Group. His appointment is part of the strategic plan to expand our strength in Information Technology.

Professor David Simchi-Levi co-authored the book *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies* (with P. Kaminsky and E. Simchi-Levi), which won several awards: the Outstanding IIE Publication Prize by the Institute of Industrial Engineers, the IIE Joint Publishers Book-of-the-Year Prize by the Institute of Industrial Engineers, and the Outstanding First Edition of the Year Prize by McGraw-Hill/Irwin. Professor Simchi-Levi has also been appointed as an Editor in the area of Supply Chain/Production-Inventory Systems for IIE Transactions.

Professor Sarah Slaughter will continue as CEO and President of MOCA Systems, the company she founded. The May 2001 issue of Fortune Small Business featured MOCA Systems as one of 65 Next Hot Companies.

Professor Joseph Sussman is working on the Mexico City project, focusing on developing top-down scenarios to identify policy options that can ameliorate the profound environmental problems of the huge city, without compromising mobility and economic growth objectives.

Professor Robert Whitman presented the Nabor Carrillo Lecture to the Mexican Society of Soil Mechanics in November 2000 on "Fifty Years of Soil Dynamics."

Professor Andrew Whittle has become an editor for the International Journal for Numerical and Analytical Methods in Geomechanics (Wiley).

Since January 2001, Professor Nigel Wilson has been leading a program with the University of Illinois aimed at making the Chicago Transit Authority more competitive in the 21st century.

Professor Shi-Chang Wooh was elected as an international advisory board member of the *Nondestructive Testing and Evaluation (NDT&E) International* Journal and is now serving the International Conference on Theoretical, Computational, and Experimental Mechanics as an advisory committee member.

RESEARCH HIGHLIGHTS

Last year, we reported that the department was initiating two banner research programs consistent with our thrusts and goals. The Intelligent City of the Future, I-City, focuses on sensing, data management and integration of information and infrastructure for operation, management, design, and maintenance. This concept is being expressed in some of our I-Campus involvement. Similarly, the idea is integral to an international initiative being explored with Delft University of Science and Technology and has been presented to colleagues in Cambridge as a potential CMI program. The Earth Systems Initiative (ESI) seeks to exploit MIT's strength in science and technology to deal with problems of the earth environment. The concept is to look at earth systematically, measuring and diagnosing its problems, characterizing and quantifying its health, and predicting its future; much like modern medicine does with the human body. CEE and the Department of Earth, Atmospheric and Planetary Sciences (EAPS) have been working closely at developing a concept and implementation plan for the initiative. There will be significant participation from others in the Schools of Engineering and Science.

A new program, patterned after the successful Tren Urbano, has been developed with the city of Chicago. Tren Urbano continues its successful activities.

Our six-year collaboration with CNR-Italy (Consiglio Nazionale delle Ricerche) continues with a lot of success and meaningful exchanges. This international program has good expansion prospects.

OTHER HIGHLIGHTS

The department has signed an agreement with Pearson/Prentice Hall to develop a new textbook series in Civil and Environmental Engineering. This initiative is consistent with our goal of influencing undergraduate and graduate education throughout the nation. Its focus on electronic and new media publications is also consistent with our goals. The first books in the series are expected in a year.

After many years of wonderful service, Professor Nigel Wilson will take a sabbatical leave and has stepped down as leader of the Engineering Systems Group. Professor Cynthia Barnhart will assume that role.

Professor Rafael L. Bras stepped down in June as Department Head after nine years in the position. Professor Chiang C. Mei has taken over as Interim Department Head until the new head is installed.

DEPARTMENTAL AWARDS AND OTHER SPECIAL RECOGNITION

Steven Margulis, a doctoral candidate and student of Dara Entekhabi was awarded Outstanding Student Paper prize at the Annual Meeting of the American Geophysical Union (May 2001).

Hrund Andradottir, a student of Professor Heidi Nepf, received a Certificate of Merit from the University Council on Water Resources (UCOWR). Her thesis was entitled, "Littoral Wetlands and Lake Inflow Dynamics."
Departmental Awards and Other Special Recognition

Winners of the Richard Lee Russel Award for outstanding seniors entering graduate studies in Civil and Environmental Engineering were Hannah Sullivan and Heather Lukas.

Jennifer Burtz '01 received the Steinberg Prize given to an undergraduate with an excellent academic record and an interest in construction management.

Yanni Tsipis '01 won the Leo (1924) and Mary Grossman Award in recognition of high scholastic standing and interest in the field of transportation. As a double major in the Department of Urban Studies and Planning (DUSP), Yanni Tsipis also won the Outstanding Undergraduate Thesis/Project Award with honorable mention going to CEE double major Stefani Okasaki '01. Stefani also won a Henry Martinelli Fellowship from DUSP.

Citing his work with city governments, the InterFraternity Council (IFC) presented the Fassett Award to Russell Spieler '01, who had been the IFC Judicial Committee Chairman.

Michelle Vidal '01 received the Howe Walker Award from the Boston Society of Civil Engineers section of ASCE on May 7, 2001.

Arjun Nair '01 won the 2001 Randolph G. Wei Undergraduate Research Opportunities Program (UROP) Award for outstanding work at the interface of the life sciences and engineering.

Junlin Ho '01 received a scholarship from the American Consulting Engineers Council (ACEC) Massachusetts chapter. Earlier she won the Simpson Gumpertz and Heger Scholarship Award.

Sara Jo Elice '01 won the Dean A. Horn Award for excellence in marine research for her thesis, "Whither the Sediment: A History and Evaluation of the Boston Harbor Navigation Improvement Project."

Matthew Van Horne '02 was selected to receive the Dr. Pedro Grau undergraduate scholarship from the American Meteorological Society.

A panel of judges gave an honorable mention to Hrund Andradottir (G) for the 2001 Universities Council on Water Resources Dissertation Award.

Daniel Feldman '02 was one of 26 sophomores selected by the School of Humanities, Arts, and Social Sciences to be a 2001 Burchard Scholar.

The New England University Transportation Center (UTC) at MIT chose Jennifer Farver (G) as its UTC Outstanding Student of the Year for 2001.

Transportion student Anne Dunning (G) won the award for best student paper at the Summer Assembly of the University Consortium for Geographic Information Science (UCGIS) in Portland, Oregon, with "A Methodology for Analyzing Correlations of Spatial Attribute Clustering with Airline Routing and Passenger Willingness to Pay."

Franz Heukamp (G) received the Hugh Hampton Young Fellowship.

Cordelia Crockett (G) received the Clare Boothe Luce Fellowship.

The Zakhartcenko Fellowship was awarded to Shan Lan (G).

Stephan D'heedene (G) was awarded the Victor J. DeCorte Fellowship.

Graduate students J. Sam Arey, Kaeo Duarte, Gavin Gong, Karim Karam, Julie Kiang, and Megan Kogut were awarded membership to the Martin Family Society of Fellows for Sustainability.

Daniel Collins (G) was awarded a National Aeronautics and Space Administration (NASA) Fellowship.

Kristin Jellison (G) was awarded an Environmental Protection Agency (EPA) Fellowship.

Jennifer Burtz '01, Junlin Ho '01, Matthew Van Horne '02 and Stefani Okasaki '01 were elected to Chi Epsilon.

More information about the Department of Civil and Environmental Engineering can be found online at http://web.mit.edu/civenv/.

Rafael L. Bras

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

The past year has again been a busy one for the Electrical Engineering and Computer Science (EECS) faculty, staff and students. In addition to new faculty and education and research initiatives, the department developed an all-encompassing strategic plan. This plan has now been discussed within EECS and presented to the MIT administration and the EECS Visiting Committee.

Most importantly, the strategic plan reaffirms the department's commitment to residential education and to doctoral student-centered research as the department's primary missions.

There are two important assumptions that lie at the heart of our strategic plan:

- The current student interest in EECS is an accurate reflection of the current relative importance of the fields that have their most natural home in EECS, and is likely to persist for the foreseeable future. To meet this demand, the department should add faculty and look for ways to provide improved educational opportunities to our students — including working with other departments and looking for innovative ways to use technology.
- We are at the start of a period of intellectual convergence in which boundaries between existing departments will be increasingly less relevant. To exploit the opportunities offered by this convergence, EECS should hire faculty jointly with other units at MIT.

If one were to use a single noun phrase to describe the intellectual core of our strategic plan, that word would be "multi-disciplinary." Three technologies will permeate much of engineering research in the 21st century: the manipulation and communication of information; the manipulation of molecular and atomic structures; and the manipulation of biology. This will lead to a convergence of the activities across many of the departments and other units that currently comprise MIT's Schools of Engineering and Science.

This convergence is not a problem, but rather a wonderful opportunity. The challenge will be to make sure that existing boundaries between units don't become barriers to joint educational and research endeavors.

In addition to working to increase the size of the teaching staff, we plan to aggressively pursue ways to exploit technology in our educational activities with the aim of improving opportunities for students at MIT. If some of the tools and materials developed should prove useful in MIT's various distance education initiatives, it would be a useful side effect. We reiterate our position that technology should be used not to depersonalize education but rather to personalize it, and not to reduce meaningful faculty/student contact but to increase it.

Our plan will be neither easy nor fast to implement. We have a lot of work to do and there will inevitably be bumps in the road. But it is hard to imagine a more exciting time to be working in EECS. We will do our best to live up to the challenge of educating the world's best students in the world's most exciting disciplines.

UNDERGRADUATE PROGRAM

Enrollment of undergraduates averaged 1,000 in 2000–2001, close to that of 1999–2000, with 15 percent in the Electrical Engineering Program (6-1), 40 percent in the Computer Science Program (6-3), and 45 percent in the Electrical Engineering and Computer Science Program (6-2). From the Class of 2003, 350 students were enrolled in Course VI. About 320 students from the Class of 2004 have so far selected Course VI, with 11percent choosing 6-1, 59 percent choosing 6-2, and 30 percent choosing 6-3.

The Master of Engineering (M.Eng.) program entered its seventh year with 227 students.

The following prizes and awards were won by our students.

The Ernest A. Guillemin Thesis Competition for outstanding performances on a Master of Engineering thesis in Electrical Engineering were won by Ozge Gozum and Colin Balthaup.

The David Adler Memorial Thesis Prizes for outstanding performance on an undergraduate thesis in Electrical Engineering were presented to Kevin O'Connor and Stanley Hong.

The Charles and Jennifer Johnson Theses Prizes for outstanding performance on Master of Engineering thesis in Computer Science were awarded to Allison Waingold and Aaron Ucko.

The Morris Joseph Levin Awards for Best MasterWorks Oral Theses Presentations were awarded Alvar Saena-Otero, Jorge R. Nogueras, David Andersen, Sidney Chang, Shelby Savage, Colin Balthaup, Samuel Schaevitz, Maya Rida Said and Deepak Bansal.

The William A. Martin Memorial Thesis Prize for outstanding performance on a Master of Engineering thesis in Computer Science was presented to Nicholas Feamster.

The George C. Newton Prize for the best undergraduate laboratory projects was awarded to Nikolai Aeldovich
The Ann Pogosyants Undergraduate Research Opportunities Program (UROP) Award was given to William Thies.

The Northern Telecom/BNR Project Awards were made to Felix Klock, Roderick Ferguson, Garrett Barter and Nathaniel Sattler.

A Departmental Special Recognition Award was presented to Warit Wichakool.

GRADUATE PROGRAM

In September 2000, there were 796 graduate students enrolled in the department. About 26 percent of the total were foreign nationals. The Department supported 465 Research Assistants and 101 Teaching Assistants. In addition, there were 178 fellowships including 42 National Science Foundation Fellows and 20 Department of Defense Fellows. The remaining students had industrial or foreign support or were using their own funds.

During 2000, the department awarded 87 Master of Science degrees, 2 Electrical Engineer degrees and 84 Doctoral degrees.

The department received 2335 applications for the 2000–2001 year, a significant increase from 1999. The applications continue to be generally excellent and 314 were admitted for 2000 (February, June and September), of whom 153 registered in September.

A number of awards were made to graduate students for excellence in teaching. Stark Draper received the Carlton E. Tucker Award and Nicholas Laneman received the Harold L. Hazen Award. The Frederick C. Hennie III Awards for excellence in teaching were presented to Eric Lehman and Jeremy Nimmer. The George M. Sprowls Awards for outstanding research contributions in the field of electronic computer and investigation research were presented to Cynthia Breazeal, David Mazieres and Salil Vadhan. Department Special Recongition Awards went to Robert Cox and David Robison.

VI-A INTERNSHIP PROGRAM

The department's VI-A Internship Program is in its 84th year. This year, we made substantial changes to the VI-A requirements to maximize flexibility for VI-A students by allowing easy entrance and exit at any time. There will be a new fall VI-A recruitment for seniors who wish to do an industry-based Master of Engineering thesis. We hope that these changes will make VI-A more attractive to students and companies. This year, 108 students applied during the annual Orientation and Selection process and 42 were selected as members of the incoming VI-A class. To compare, in 2000, 73 students applied and 41 were selected. Since the last report, approximately 21 students have withdrawn from the VI-A Internship Program as they felt their needs were better matched with opportunities available on-campus. However, most VI-A students find this program professionally rewarding and a source of great satisfaction as indicated by their Mid-Term and Final Reports and by the quality of their M.Eng. theses. Every effort is made to ensure that VI-A companies continue to offer challenging and well supervised assignments to VI-A students, enabling them to gain valuable industrial experience.

Two new companies joined VI-A this year—Apple Computer Corporation in Cupertino, CA and Mobilian Corporation in San Diego, CA. Many companies did not take new VI-A students this year because of the downturn in the economy, but most will continue with those students selected in previous years. Other companies continue to express an interest in participating in the program.

In June, 22 VI-A students received the M.Eng. degree having completed all their company assignments and Institute degree requirements. There were 32 VI-A students who were awarded their Bachelor's degree and most of them will continue into the graduate phase of the program.

Many honors and awards continue to be bestowed on VI-A students. Michael H. Vogel (Draper) was one of the 26 sophomores and juniors who were selected as 2001 Burchard Scholars. These awards are given to students who have demonstrated excellence in some aspect of the humanities, arts, and social sciences.

Hau Hwan (AT&T) was selected as one of the Siebel Scholars at MIT. The Siebel Scholars program was established to recognize the most talented students at leading graduate schools of business and computer science.

At the 2001 Institute Awards Convocation, Edward A. Keehr (QUALCOMM) received the Admiral Edward L. Cochrane Award, which is presented to a male senior who has shown the highest qualities of humility, leadership, and inspiration in intercollegiate athletics.

FACULTY NOTES

Five new faculty joined the Department this year:

- Julie Dorsey, Associate Professor of Electrical Engineering and Computer Science and Architecture, who received her Ph.D. from Cornell University.
- Vahid Tarokh, Associate Professor of Electrical Engineering and Computer Science, who received his Ph.D. from the University of Waterloo.
- Vladimir Bulovic, Assistant Professor of Electrical Engineering and Computer Science, who received his Ph.D. from Princeton University.

- Michael D. Ernst, Assistant Professor of Electrical Engineering and Computer Science, who received his Ph.D. from the University of Washington.
- Piotry Indyk, Assistant Professor of Computer Science and Engineering, who received his Ph.D. from Stanford.

There were six promotions in the department. Assistant Professors Saman Amarasinghe and Leonard McMillan were promoted to Associate Professor. Associate Professors David R. Karger, Daniel Jackson and Alexandre Megretski received tenure. Associate Professor Frans Kaashoek was promoted to Professor.

Professor Arvind, Professor Barbara Liskov, Professor Alan Oppenheim, Professor Ronald Rivest, Professor Jacob White, Professor Peter Hagelstein, and Professor Bernard Lesieutre were on sabbatical for all or part of the year.

Professors Thomas Weiss, Abraham Bers, Amar Bose, Robert Gallager, and Hermann Haus retired from the faculty.

The department hosted seven visiting faculty. Professor Sherra Kerns, from Vanderbilt University, was hosted by Paul Penfield. Professor Katrin Kneipp, from Technische Universitat Berlin, was hosted by Mildred Dresselhaus. Professor Jose Moura, from Carnegie Mellon University, was hosted by Sanjoy Mitter. Associate Professor Peter Druschel, from Rice University, was hosted by Frans Kaashoek. Associate Professor D.N.C. Tse, from University of California at Berkeley, was hosted by Vincent Chan. Associate Professor Manuela Veloso, from Carnegie Mellon Univeristy, was hosted by Professor Rodney Brooks. Assistant Professor Hava Siegelmann, from Technion University, was hosted by John Tsitsiklis.

Faculty Awards and Honors
Professor Krste Asanovic received a 2001 National Science Foundation Career Award.

Professor Hari Balakrishnan received the Ruth and Joel Spira Award for Distinguished Teaching.

Professor Dimitri Bertsekas was elected to the National Academy of Engineering. He also received the ACC John R. Ragazzini Education Award and the Greek National Award on Operations Research.

Professor Jesus del Alamo received the Louis D. Sullivan Award.

Professor Michael Dertouzos received an honorary Doctorate from Aristotelian University, in Thessaloniki, Greece in November 2000. He also was appointed to TIBCO Founder's Chair.

Professor Mildred Dresselhaus was elected as an Honorary Member of the Loffe Institute, at the Russian Academy of Sciences, St. Petersburg, Russia. She also was awarded the 2001 Karl T. Compton Medal for Leadership in Physics and 2000 National Materials Advancement Award from the Federation of Materials Societies. In addition, Professor Dresselhaus was awarded the 2000 Weizmann Women and Science Millennial Lifetime Achievement Award.

Professor Dave Forney was elected to Massachusetts Telecom Council Hall of Fame.

Professor Jim Fujimoto was elected to the National Academy of Engineering.

Professor Shafi Goldwasser was elected to the American Academy of Arts and Sciences. She also received a 2001 Godel Award.

Professor Eric Grimson received the Bose Award for Excellence in Teaching.

Professor Hermann Haus was awarded the 2001 Willis E. Lamb Medal.

Professor Erich Ippen received the Killian Award.

Professor Butler Lampson was awarded the 2001 Institute of Electrical and Electronics Engineers (IEEE) von Neumann Medal.

Professor Nancy Lynch was elected to the National Academy of Engineering.

Professor Roger Mark was awarded the Frank Perkins Award for Excellence in Graduate Advising.

Professor Leonard McMillian received the Junior Bose Award for Excellence in Teaching.

Professor Muriel Medard received a 2001 National Science Foundation Career Award.

Professor David Perreault received the IEEE Richard M. Bass Outstanding Young Power Electronics Engineer Award.

Professor Madhu Sudan received a 2001 Godel Award and the 2000 IEEE Information Theory Society Paper Award.

Professor Vahid Tarokh received the 2001 Alan T. Waterman Award.

Senior Lecturer Christopher Terman received the Departmental Special Award.

Professor Greg Wornell was elected as a Senior Member of the IEEE.

Professor Markus Zahn was appointed to the Thomas and Gerd Perkins Professorship of Electrical Engineering.

More information about the Department of Electrical Engineering and Computer Science can be found online at http://www-eecs.mit.edu/.

John V. Guttag

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

The Department of Materials Science and Engineering (DMSE) continues its intellectual and educational leadership, capturing the top position in the *US News and World Report* ranking of graduate programs offered by materials science departments nation-wide for the twelfth consecutive year. Professor Nicola Marzari will be joining our faculty and a brief description of his background can be found in the following pages. Department faculty and students continue to be honored with prestigious awards and medals from various professional societies and international organizations. We have initiated extensive and exciting renovations and modernization of many of our facilities, including laboratories, faculty and student offices, and administrative space; these projects will be discussed later in this document.

Our total enrollment stands at approximately 300 students, including five students who began our new Master of Engineering program in June of this year. The Department Graduate Committee, chaired by Professor Harry Tuller, has worked diligently this year in restructuring our graduate degree programs and creating four new academic programs: Bio- and Polymeric Materials; Electronic, Photonic, and Magnetic Materials; Emerging and Fundamental Studies in Materials; and Structural and Environmental Materials. Our Undergraduate Committee, chaired by Professor Ron Latanision, and the undergraduate instructors have spent the past year in intensive self-assessment in preparation for an accreditation visit from the Accreditation Board for Engineering and Technology (ABET) in Fall 2001.

Faculty members from the department continue significant involvement with major Institute initiatives. Six department faculty members are affiliated with the Singapore–MIT Alliance (SMA) and Professor Carl Thompson is the MIT Co-Chair of the Advanced Materials for Micro- and Nano-Systems Programme. The Cambridge-MIT Institute (CMI), a global alliance with Cambridge University, is directed at MIT by Professor John B. Vander Sande.

Several major new research efforts, funded through the Multi-University Research Initiative Program (MURI), the Defense University Research Initiative on NanoTechnology Program (DURINT), and the National Science Foundation (NSF), were awarded to DMSE colleagues and their MIT collaborators in the past year. The following list provides a summary of these programs, all of which are multi-departmental and, in most cases, multi-institutional efforts, and are led by DMSE faculty or have active participation from DMSE faculty.

- "Hybrid active FSMA/Polymer Micro-Composites and Electrostrictors" (MURI grant funded by the Office of Naval Research); Principal Investigator (PI): Dr. Robert O'Handley; co- PIs: Professor Yet-Ming Chiang and colleagues from MIT, University of California, Los Angeles, and University of California, San Diego; level of funding: $950,000 per year for three years with an optional $1,000,000 per year for two additional years.
- "Micromechanical Systems for Fuel Processing and Conversion to Electrical Power" (MURI grant funded by the Army Research Office); PI: Professor Klavs Jensen; co- PIs: Professor Harry Tuller and colleagues from other MIT departments; level of funding: $3,166,727 for three years, with an optional $2,971,398 for an additional two years.
- "Nanostructured and Interfacial Materials" (DURINT grant funded by the Office of Naval Research); PI: Professor Subra Suresh; with collaborators from MIT, Rutgers University, Institute of NanoTechnology, Karlsruhe, Technical University of Berlin, Argonne National Laboratory, and Lawrence Livermore National Laboratory; level of funding: $3,000,000 for three years, with an optional $2,000,000 for an additional two years.
- "A Comprehensive Experimental Facility for Nano- and Meso-Scale Mechanical Behavior of Nanostructured Materials and Coatings" (DURINT Equipment Grant funded by the Office of Naval Research); PI: Professor Subra Suresh; level of funding: $500,000; this funding will add valuable new equipment and resources to the NanoMechanical Technology Laboratory in DMSE.
- "Polymeric Nanocomposites" (DURINT grant funded by the Air Force Office of Scientific Research); PI: Mary Boyce (Mechanical Engineering); co- PIs: Professor Ned Thomas and colleagues from MIT and the University of Akron; Level of funding: $3,000,000 for three years, with an optional $2,000,000 for an additional two years.
- "Nanometer Scale Induced Structure Between Amorphous Layers and Crystalline Materials" (grant funded by NSF and the European Union): PI: Professor W. Craig Carter; co- PIs: Professor Yet-Ming Chiang and colleagues at the University of Missouri, Kansas City; Rutgers University; the University of Pennsylvania, Lawrence Berkeley National Laboratory (LBNL), Dupont, Oxford University, the University of Karlsruhe, MPI (Max-Planck-Institut) Stuttgart, and CEA (Commissariat à l'Energie Atomique) Saclay; level of funding: $1,703,818 over three years among the US universities; the EU will provide a similar amount to the European researchers.

Another project awarded this year is the "Summer Institute in the Materials Science of Material Culture," Professor Heather N. Lechtman, PI; Professors Dorothy Hosler, Samuel Allen, and Linn Hobbs, co- PIs. This grant was made through NSF's Division of Materials Research and is expected to provide $250,000 per year for a three-year period to bring faculty from liberal arts universities to our campus to pursue the study of archaeological and ethnological materials through materials science research.

UNDERGRADUATE EDUCATION

Our undergraduate enrollment remains steady at about 105 students and currently includes 66 percent women, nine percent underrepresented minorities, and five percent international students. We continue extensive recruiting efforts to maintain our undergraduate student body, including participation in Academic Expo during Freshman Orientation, an Open House, the annual John Wulff Lecture, direct mailings to the freshman class, Freshman Advisor Seminars, and Independent Activities Period (IAP) Activities. Our III–B Internship Program continues to attract the majority of DMSE undergraduates; 45 DMSE students were placed at 27 host institutions during the summer of 2001.

Professor Lorna Gibson and Professor Linn Hobbs have worked this past year with the Cambridge-MIT Institute (CMI). Two DMSE students participated in an exchange with the Department of Materials Science and Metallurgy at Cambridge University during fall 2000 and two participated during the spring semester. During IAP, a short course on Materials Selection and Design was presented both to MIT and to Cambridge University students through distance learning. Three students from Cambridge will participate in research projects at MIT this summer and two Cambridge students will enroll in classes at MIT in the fall semester 2001. One DMSE undergraduate will be going to Cambridge in the fall semester 2001.

GRADUATE EDUCATION

The department has a very healthy graduate student enrollment, which currently stands at 172. Approximately 25 percent of our graduate students are women and 2.8 percent are underrepresented minorities. The following table shows the distribution of students among our Ph.D. graduate degree programs as of February 2001.

Table 1. Distribution of Students Among Ph.D. Graduate Degree Programs

Degree Program	Percent of Total Graduate Students
Ceramics	10.5%
Electronic Materials	33.1%
Materials Engineering	9.9%
Materials Science	13.3%
Metallurgy	4.7%
Polymers	14.5%
Biomaterials	1.8%
Masters (III-B, S.M., and M.Eng.)	12.2%

Two of our students were enrolled in the Technology and Policy Program (TPP) and six were enrolled in the Leaders for Manufacturing Program (LFM). Sixteen of our polymer students were enrolled in the Program for Polymer Science and Technology (PPST). We anticipate for the fall of 2001 a total graduate student enrollment of about 185. Our continuing work to expand offers of one- and two-semester fellowships to a large percent of domestic applicants has been successful. We will register an incoming class of fifty for the coming fall, over 70 percent of whom are domestic.

Nearly all undesignated gifts to the department are currently being used to fund endowed fellowships (including the Nicholas J. Grant Fellowship, the John F. Elliott Fellowship, the Ronald A. Kurtz Fellowship, the Gilbert Y. Chin Fellowship, the R.L. Coble Fellowship, the Carl M. Loeb Fellowship, the David V. Ragone Fellowship, the H.H. Uhlig Graduate Fellowship, the Stuart Z. Uram Fellowship, the Class of '39 Fellowship, the Julian Szekely Fellowship, the Anthony D. Kurtz Fellowship, and the Department Endowed Fellowship). Our endowed fellowships now provide sufficient annual income for one-semester fellowships for approximately four students and two-semester fellowships for seven students. In addition to the above, we are grateful recipients of a number of grants from corporations and foundations to aid our first-year students. We have received three fellowships from the Whitaker Foundation, an Ida Green Fellowship, and a Leventhal Fellowship. These have been instrumental in assisting us in maintaining the size and quality of our incoming domestic student class. We have fellowship support from a number of corporations including SRC and Lucent Technologies. In addition, many students have other outside fellowship support; of the 35 domestic students expected to enter in the fall of 2001, 21 will be entering on fellowships from the department and from a variety of sources including: MIT, NSF, Department of Defense (DOD), and the National Defense Science and Engineering Graduate (NDSEG) program.

This spring the department voted to replace the present degree programs in Electronic Materials, Ceramics, Polymers, Biomaterials, Metallurgy, Materials Science, and Materials Engineering with four new academic programs: Bio- and Polymeric Materials; Electronic, Photonic, and Magnetic Materials; Emerging and Fundamental Studies in Materials; and Structural and Environmental Materials. These new programs, which focus on the integrative nature of the field rather than on specific materials classes, will begin this fall. The current programs (including the existing interdepartmental Archaeological Materials program) are described below.

The Bio- and Polymeric Materials curriculum concentrates on the science and technology of synthetic and natural materials characterized by carbon-bonded, long-chain molecules of seemingly limitless architectural diversity, and their composites with inorganic materials. Polymer and nanocomposite processing by molecular-level assembly, self-assembly, and field-directed approaches are employed to create new materials displaying a wide range of structure and properties. Materials Science and Engineering principles are applied to the development of new

products and therapies including photonic devices, battery electrolytes, organic Light Emmiting Diodes (LEDs), filtration membranes, highly recyclable plastics, resorbable implants, biosensors, and drug delivery devices.

The Electronic, Photonic, and Magnetic Materials program includes the science and technology of materials for electrical, magnetic, and optical device applications. It is concerned with the design and fabrication of useful materials and devices through understanding and control of the interplay between electronic, magnetic, and optical properties; the micro- and nanostructure of materials (atomic arrangements, defects, interfaces, phase constitution, and morphology); and processing methods. Research within this field includes materials processing in bulk and thin-film form; device fabrication; characterization of the semiconducting, dielectric, optical, and magnetic properties of materials and devices; and theoretical study of the characteristics of bulk materials, thin-film materials, and interfaces and their implications for devices.

The Emerging and Fundamental Studies in Materials program encompasses the study of fundamental and emerging concepts and technologies in Materials Science and Engineering. The common principles that underlie the structure and properties of materials are those associated with electronic structure and bonding, atomic arrangement, phase stability, and the role of imperfections and microstructure. Fundamental phenomena considered include structural and phase transformations, reactivity, mass and charge transport, and the optical, electronic, and mechanical response to internal and external stimuli. Tools of study include theory, computer modeling, and experimental characterization methods such as electron microscopy and diffraction. This program also stimulates the integration of important developments from other fields such as Mathematics, Biology, Physics, and Economics into Materials Science and Engineering, and allows students to propose relevant interdisciplinary course programs that may lead to emerging disciplines in Materials Science and Engineering.

The Structural and Environmental Materials program encompasses the study of the mechanical response of materials to internal and external stimuli as well as the design and use of materials to minimize environmental impact. Examples of research topics in the area of Structural Materials include microelectromechanical systems (MEMS), nanomechanics, functionally graded materials, superalloys, ceramic turbine blades, polymers, biomimicking of natural structural materials, and mechanics of cellular materials. Examples of topics in Environmental Materials include: processing to minimize materials degradation and environmental impact, recycling of materials, materials for energy conversion and storage (e.g., advanced battery systems, fuel cells, solar photovoltaics, smart windows, and hydrides), and sensors and actuators for environmental monitoring and control.

The Archaeological Materials field utilizes the scientific principles and laboratory methods of Materials Science and Engineering to study the natural and cultural artifacts central to archaeological inquiry. It involves determination of the materials of early and non-industrial societies exploited from the natural environment, their processing, and the engineering design that, together, transformed them into cultural objects. Research includes archaeological fieldwork coupled with laboratory analysis and experiment in an effort to reconstruct the materials technologies of societies known principally from their archaeological remains.

The department initiated an exciting new program of invited lectures on current research and activity in the field of Materials Science and Engineering. Our first-year graduate students were strongly urged to attend and the rest of the Department and the MIT community were invited. The six lectures were well-attended, some standing-room-only, and we plan to continue the program next year. This year's invited speakers included: Professor Michael F. Ashby of the University of Cambridge; Professor Jeffrey Hubbell of ETH and the University of Zurich; Professor Edward J. Kramer of the University of California, Santa Barbara; Professor Shuji Nakamura of the University of California, Santa Barbara; Dr. Stuart S. P. Parkin of IBM Almaden Research Center; and Professor George M. Whitesides of Harvard University.

Master of Engineering Degree in Materials

This new degree program was approved in 2000 and the first class of students was accepted for summer 2001 enrollment. Five students with backgrounds ranging from Mechanical Engineering/Materials Science and Engineering to Athletic Physiology began the program this June. They have enrolled in 3.205 Thermodynamics and Kinetics and 3.225 Properties of Materials for the summer semester; these two subjects provide an overview of the traditional DMSE graduate core. In addition to those subjects, they are attending 3.206 Introduction to Materials Engineering Practice Speaker Series. The series includes seminars by Professor Michael Cima speaking on "Materials for Microdevices and Manufacturing Tools," Mr. Jurgen Michel speaking on "Silicon Microphotonics," Mr. Vladimir Bulovic speaking on "Organic Materials for 21st Century Optoelectronic Applications," Professor Carolyn Ross speaking on "Magnetic Materials for Data Storage," Professor Michael Rubner speaking on "New Multilayer Coating Tech. Based on Polyelectrolytes," Mr. Mayank Bulsara speaking on "Transitioning Technology (and Career Paths) from Research to Commercial Application," and Professor Yoel Fink speaking on "Hollow Dielectric Fibers and the Future of Telecommunications." The students must complete coursework on campus during fall semester and will complete either an on-campus engineering project and technology evaluation course or an off-campus project, arranged through a faculty advisor, at an industrial site. Students who choose to pursue the on-campus option for the spring semester will attend a class that features both speakers and sessions that guide their project. Speakers will be chosen to compliment project development and will include technologists, patent attorneys, entrepreneurs, and financiers.

STUDENT ORGANIZATIONS

Officers of the Society of Undergraduate Materials Students (SUMS) for 2000–2001 are Jeff Colton, President; Lauren Frick, Vice-President; Brad McCoy, Secretary; and Jamie Mak, Treasurer.

The Graduate Materials Council (GMC) officers for 2001–2002 will be Marc Richard, President; Ashley Predith, Vice President; Ellen Siem, Treasurer; Lori Kensel and Ryan Williams, Social Chairs; Todd Stefanik and Joe Bullard, Athletic Chairs; Douglas Cannon and Garry Maskaly, Departmental Committee for Graduate Studies (DCGS) Representatives; and Josh Hertz, Graduate Student Council (GSC) Representative.

PERSONNEL

We are pleased to announce that Nicola Marzari will be joining our faculty as an Assistant Professor working in the field of computational materials in August 2001. Most recently, Professor Marzari has been a research staff member at Princeton University where his research used computer modeling and simulation studies based on first-principles quantum theory to study the atomic structure, dynamics, and underlying electronic structure of real materials. He holds a Ph.D. in physics from the University of Cambridge. We are also pleased to announce that Professor Anne Mayes has been promoted from the rank of Associate Professor to the rank of Full Professor, effective July 1, 2001. Professor Caroline Ross has been promoted to the rank of Associate Professor with Tenure, effective July 1, 2001. As mentioned in last year's report, Darrell Irvine will join our faculty for fall semester 2001. Professor Irvine holds a Ph.D. from the department and has spent the past year in postdoctoral study in immunotherapy at Stanford University.

Professor Merton C. Flemings and Professor Kenneth C. Russell have both retired from the department as of July 1, 2001. Professor Flemings holds an S.B., an S.M., and an Sc.D. in Metallurgy from MIT and joined our faculty in 1956. He has served as Head of the Department of Materials Science and Engineering, as Director of the Materials Processing Center, as Associate Director of the Center for Materials Science and Engineering, and most recently as Co-Director at MIT of the Singapore-MIT Alliance. Professor Russell joined the DMSE faculty in 1964 after completing a Ph.D. in Metallurgical Engineering at the Carnegie Institute of Technology. In recent years, Professor Russell has served on the Department Graduate Admissions Committee and has been an able resource in matching graduate students with open Teaching and Research Assistantships. Although retired, both Professor Flemings and Professor Russell will continue working with the department and with the Institute. Professor Chris Scott resigned to take a position at Exponent Failure Analysis Associates at the beginning of spring semester 2001.

RESEARCH HIGHLIGHTS

Research in Professor Allen's group is working develop materials systems and processes for fabricating metal parts by Three-Dimensional Printing, and in characterization of ferromagnetic shape-memory alloy actuators. Professor Carter and his students develop a wide range of computational approaches to understand fundamental aspects of microstructure development and their effects on materials properties in diverse materials that range from bone to relaxor ferroelectrics. Professor Ceder's group has developed an understanding of an electronic origin for diffusion in manganates that has promise for the development of improved rechargeable lithium battery systems. Professor Chiang and his students have developed a new family of alkaline-bismuth perovskites, which in polycrystalline form exhibit properties comparable to current lead-perovskites such as PZT and PMN. Professor Cima's work focuses on the processing and fabrication of complex ceramic and electronic components via Three-Dimensional Printing and microfabrication/micromolding, biomedical applications and controlled-release drug delivery, and thin-film superconductors. Professor Clark developed a methodology for predicting costs of virtual designs of autobodies that incorporates alternative materials and processes.

In Professor Eagar's group, a new method of scaling order-of-magnitude solutions of complex combinations of differential equations has been developed and demonstrated for modeling of welding processes. Professor Fink's group has initiated research on the synthesis of novel high-purity optical materials which include: Chalcogenide glasses, block-copolymers, and SnS_2 nanocrystals. Professor Fitzgerald's group is exploring mobility enhancements in heterostructure MOSFETs (Metal-Oxide-Semiconductor Field-Effect Transistors) grown on relaxed SiGe virtual substrates. Professor Flemings initiated a research program to produce three-dimensional structural metallic MEMS components by metal casting. Professor Gibson and her students are studying cell-matrix interactions in porous scaffolds used in skin regeneration. Professor Hobbs' work on orthopedic joint prosthesis materials has investigated the formation of new bone apposing hydroxyapatite-coated cementless implants in hip prostheses. Professor Hosler continues her work on rubber processing technology and on the development of metallurgy in ancient Mesoamerica. Professor Latanision's group has developed an approach for corrosion protection of reactor materials by control of the in-reactor water chemistry. Professor Lechtman carried out mineralogical and lead-isotope analyses of copper ores she assembled from mines and ore deposits in Chile, Argentina, and Bolivia. Professor Lupis explored the application on Input-Output Models to the optimization of the flow sheets of large metallurgical plants and the impact of regulations on emissions of carbon dioxide and other greenhouse gasses.

Professor Mayes' group has developed a simple analytical model for the free energy of mixing of compressible polymer blends, based on a modification of the regular-solution model that has been used to predict phase diagrams for 30 separate blend systems. Professor McGarry's group is working to improve the fracture toughness of rigid silicone resins. Dr. O'Handley and his students have studied the effects of strain on magnetic thin-film properties, and also made significant advances in characterizing ferromagnetic shape-memory actuator performance at

frequencies up to several hundred Hz. Professor Ortiz's group focuses on nanomechanical studies of noncovalent, intra-, and intermolecular interactions in biological and biomimetic macromolecular systems using techniques such as high-resolution force spectroscopy and atomic-force microscopy. Professor Paul is studying the interaction between two ferromagnetic grains with grain boundary structure in the presence of segregation.

Current research in Professor Powell's group includes modeling of the Electric Field-Enhanced Smelting and Refining of Steel Project, using fluid-flow and phase-field approaches. Professor Ross' group has succeeded in making the smallest magnetoresistive elements and characterizing their properties. Professor Roylance's research has centered on process-structure-property investigations of polymers and composite materials, dealing especially with mechanical properties.

Professor Rubner and his group have devised a simple spin-coating technique for fabricating thin-film light-emitting devices from ruthenium complexes that have high brightness and long lifetimes. Professor Russell is studying materials systems that are self-organizing under irradiation. Professor Sadoway's group has designed, constructed, and tested a flexible, thin-film microbattery that has exhibited record-breaking values of energy and power density. Since joining the Department in August 2000, Professor Smith's research has focused on correlating the structure and properties of surface-active materials, and understanding the mechanics of surface-mediated processes such as those occurring at Li-ion battery electrodes. Professor Suresh's group has developed a variety of new theoretical and experimental methods for the analysis and measurement of mechanical and coupled properties of small-volume structures, thin films and active materials; several patents filed based on these discoveries are currently being pursued by industry for a variety of practical applications.

Professor Thomas's group has used directional solidification and epitaxy to obtain precise control of nanopatterns in block copolymer microdomains. Through experiments and modeling, Professor Thompson and his students have demonstrated that the conventional methods for making circuit-level estimates of the reliability of IC interconnects are inaccurate, and are neither consistently conservative nor optimistic. Professor Tuller's group has been exploring lead perovskite systems as potential candidates for high-strain actuators with large thermal stability and low hysteresis. Professor Vander Sande is studying high magnetic-field processing of superconducting oxides at elevated temperatures to produce highly textured, high-performance superconducting wires. Professor Witt's group conducted solidification experiments to optimize the design of a crystal growth research facility for the International Space Station. Professor Wuensch's group has determined the atomistic nature of chemically-driven disorder processes using *in-situ* neutron diffraction experiments at temperatures up to 1500°C.

AWARDS AND HONORS

Professor Anne Mayes was named a MacVicar Faculty Fellow this year. Lorna Gibson, Matoula S. Salapatas Professor of Materials Science and Engineering, was named a Fellow of the American Society of Mechanical Engineers International (ASME) this March. Professor Donald R. Sadoway was elected a member of the Norwegian Academy of Technological Sciences this past year. Professor Samuel M. Allen was named a Fellow of ASM International, the society for materials engineers and scientists, last October. In April, Professor Yet-Ming Chiang, along with Harold D. Ackler, was presented with the Ross Coffin Purdy Award for the best paper in the *Journal of the American Ceramics Society*. Professor Linn Hobbs was named an Officer of the Order of the British Empire (OBE) for Services to UK-US Academic Relations in recognition for his work with the British Marshall scholarships. The formal investiture will take place in September at the British Embassy in Washington D.C. Professor Subra Suresh received the Distinguished Scientist/Engineer Award of The Minerals, Metals, and Materials Society (TMS) at the Society's annual meeting in February. The award recognizes an individual who has made a long-lasting contribution to the fundamental understanding of microstructure, properties, and performance of structural materials for industrial applications. Professor Suresh delivered the third annual Kelly Lecture at Cambridge University on June 14, 2001. This lecture is sponsored and hosted by the Gordon Laboratory and the Department of Materials Science and Engineering at Cambridge. The lecture was entitled "Nano- and Micro-Scale Mechanical Properties for Miniature Technologies."

Among this year's inductees to MIT's Quarter Century Club were Leslie Lawrence and Professors Joel Clark and Harry Tuller.

The department was proud to have three of its employees presented with a School of Engineering Infinite Mile Award for Excellence. Mindy L. Baughman was recognized for her work with the "MIT Artists Behind the Desk" series. Kathleen R. Farrell and Angelita Mireles were both recognized for their dedication to students and their hard work in the Department's Student Services Office.

FACULTY NOTES

Faculty members of this department include these chairholders: Samuel M. Allen, POSCO Professor of Physical Metallurgy; W. Craig Carter, Thomas Lord Associate Professor of Materials Science and Engineering; Gerbrand Ceder, Union Minière Professor of Materials Science and Engineering; Yet-Ming Chiang, Kyocera Professor of Ceramics; Michael J. Cima, Sumitomo Electric Industries Professor of Engineering; Eugene Fitzgerald, Thomas Lord Professor in Materials Science; Merton C. Flemings, Toyota Professor of Materials Processing; Lorna Gibson, Matoula S. Salapatas Professor of Materials Science and Engineering; Lionel C. Kimerling, Thomas Lord Professor of Materials Science and Engineering; Christine Ortiz, John Chipman Career Development Assistant Professor;

Adam C. Powell IV, Thomas B. King Assistant Professor of Materials Engineering; Michael F. Rubner, TDK Professor of Materials Science and Engineering; Donald R. Sadoway, John F. Elliott Professor of Materials Chemistry; Richard L. Smith, AMAX Career Development Assistant Professor; Subra Suresh, R. P. Simmons Professor of Materials Science and Engineering; Edwin L. Thomas, Morris Cohen Professor of Materials Science and Engineering; Carl V. Thompson, Stavros Salapatas Professor of Materials Science and Engineering; John B. Vander Sande, Cecil and Ida Green Distinguished Professor; and August F. Witt, Ford Professor of Engineering.

STUDENT AWARDS

Undergraduate Awards

The department award for Outstanding Senior Thesis was presented to Jennifer Meanwell of Ashland, OH, for her thesis entitled "Technical Choice in Pottery Production: A West Mexican Example." The Best III-B Internship Report award was presented to Yuri Shona Pek of Singapore for projects on "Fabrication and Study of Starch-Based Scaffolds for Tissue Engineering" and "Fabrication and Study of Hydroxyapatite-Glass Ionomer Cement (HA-GIC) Composites for Bone Cement Applications." The award for Outstanding Service to the DMSE Community was presented to Jeffrey J. Colton of Garden Grove, CA. Certificates of Honor for a Perfect 5.0 Cumulative Grade Point Average were presented to Jeremy Cheng of Longmeadow, MA, Albert Hung of Los Altos, CA, Mark Jhon of Pittsburgh, PA, Yuri Shona Pek of Singapore, and Juwell Wu of Tustin, CA. The Foundry Education Foundation (FEF) Scholarships for Outstanding Students with an Interest in Metals Casting were awarded to Amanda P. Smith of Rockport, ME, and Tina Shih of Flushing, NY. Yulun L. Hsi of Potomac, MD was named Outstanding Junior in the DMSE Class of 2002 and Jeremy Cheng of Longmeadow, MA was named Outstanding Student in the DMSE Class of 2001.

Tau Beta Pi inductees this year were Harald Hoegh, Mark H. Jhon, Trisha M. Montalbo, Jill O. Nagle, Caroline Rhim, Tiffany S. Santos, and Lisa A. Scoppettuolo.

DMSE undergraduates who received research awards from the Division of Bioengineering and Environmental Health were Kristin Niece of Covington KY, Yuri Shona Pek of Singapore, and Lara Abaschian of Gainesville, FL. Elected to Phi Beta Kappa membership were Mark H. Jhon of Pittsburgh, PA, and Jennifer H. Meanwell of Ashland, OH. Athletic awards were presented to Kelli A. Griffin (soccer) of Tiverton, RI, to Jennifer A. McKeehan (fencing) of Cambridge, MA, and to Jeffrey J. Colton (water polo) of Garden Grove, CA.

Graduate Awards

Dinesh Balachandran was one of two MIT GSC members presented with the MIT Career Fair Award. Krystyn Van Vliet and Andrew Gouldstone received first prize in the Bodycote Metal Technology Paper Competition. They were awarded $3000 and presented their winning paper, "Determination of Mechanical Behaviour via Instrumented Indentation: Application to Coated Material Systems," at the Bodycote International PLC Annual Dinner in November 2000. The John Wulff Award for Excellence in Teaching was presented to David Dussault of Medford, MA.

FUTURE PLANS

Three department search committees are actively pursuing faculty candidates in the areas of Materials Biotechnology (two-key appointment with BEH), Materials Processing and Properties, and Materials for Engineered Systems (two-key appointment with ESD).

Several major renovation and construction projects have been initiated with work to continue over several years. Some of the projects are detailed below:

- A state-of-the-art distance learning classroom, funded by and to be shared with CMI and SMA. This 700 square foot space will have seating for twenty and will be completed before the fall semester, 2001.
- SMA and CMI Headquarters containing offices for primary staff people and directors. Construction will be completed by August 15, 2001. This space has been loaned by DMSE for a period of five years in exchange for a complete renovation.
- DMSE Graduate Student Lounge containing a kitchenette, seating areas, Athena terminals, and a facility for rehearsing presentations. The design was selected by student vote and work is expected to be completed on September 1, 2001.
- A new student office in the basement of Building 8. This 950 square foot space will be shared by 24 incoming graduate students and will have cubicle partitions and wireless internet connections. It will also be ready for use for this fall semester.

Other upcoming Building 8 projects include a 1000 square foot Biomaterials Laboratory to be used by Professor Darrell Irvine and his group, a 1250 square foot Nanomechanics Lab, undergraduate teaching labs, and a computational materials science laboratory and faculty office suite. Through an agreement with the Physics Department and the Institute, DMSE will be creating a number of new undergraduate and graduate teaching laboratories and research facilities in Building 8 on the infinite corridor. Architects are working with the department to design new DMSE Headquarters, a Student Services Office, and faculty offices on the first floor of Building 6.

More information about the Department of Materials Science and Engineering can be found online at http://dmse.mit.edu/.

Subra Suresh

DEPARTMENT OF MECHANICAL ENGINEERING

Professor Nam P. Suh, who was the Department Head for the past 10 years, stepped down from this position on June 30, 2001. His vigorous and farsighted leadership has transformed the department dramatically. His vision was to "transform the field of mechanical engineering from a discipline that has been primarily based on physics into one that is based on physics, information and biology."

During his tenure, the department has seen the creation of an unprecedented number of new or upgraded facilities including the d'Arbeloff Laboratory for Information Systems and Technology, the Pappalardo Undergraduate Laboratory, the AMP Laboratory for Materials, the Rohsenow Laboratory for Heat Transfer, the Cross Student Lounge, the Cross Computer Aided Design (CAD)/Computer Aided Manufacturing (CAM) Laboratory, the BJ and JH Park Lecture Halls, the Hatsopoulos Laboratory for Micro-Fluid Dynamics, and the Papken Der Torossian Undergraduate Computing Facility. In addition, the undergraduate curriculum underwent a dramatic revision under Professor Suh's guidance. Our new curriculum integrates disciplinary material, has increased hands-on learning, trains students in active learning, and blends analysis with synthesis. During this time the expertise of the faculty grew, with new faculty hired in Bioengineering, Optics, Molecular Modeling, Micro-scale Heat Transfer, Micro- and Nano-scale Mechanical Engineering, and Information. At the same time the traditional areas of mechanical engineering retained their vitality through a number of strong hires in those areas.

Two new facilities were opened this year: the Cross Student Lounge in Building 3 and the Cross CAD/CAM Laboratory in Building 35. The lounge is used extensively by our students for both academic and social purposes. The department supplies it with newspapers and coffee each weekday. The creation of the CAD/CAM Laboratory has provided a much-needed upgrade and is used in both undergraduate and graduate classes. Both of these facilities were made possible through a generous gift from Mr. Ralph E. Cross, a long time friend and supporter of the department.

Construction of the BJ and JH Park Lecture Halls in Building 3, to replace the traditional classrooms 3-270 and 3-370, has begun. This construction is not a simple renovation. One of the new rooms will allow us to implement a new hands-on self-discovery mode of education; here students will carry out simple experiments during lecture, where they will discover and think about various phenomena and concepts. Special tables, that can be used as regular desks as well as laboratory work-tables, were designed for this room by Professor Emanuel Sachs. Each desk has AC and DC power, compressed air, a tool box, and an internet connection. In addition, the Singapore-MIT Alliance will use these rooms for distance education and they have financed state of the art equipment for this purpose. Construction of these classroom was made possible by a generous gift from Dr. and Mrs. BJ Park. Dr. Park is an alumnus of our department.

A complete renovation of the Fluid Mechanics Laboratory has commenced, leading to the creation of the Hatsopoulos Laboratory for Micro-Fluid Dynamics. It was made possible by a generous gift from Dr. George and Mrs. Daphne Hatsopoulos, long time friends and supporters of the department.

This was the first year of operation of the Cambridge-MIT Institute, a broad-ranging collaboration between the University of Cambridge and MIT. A pilot undergraduate exchange was initiated under the leadership of the Department of Mechanical Engineering. Seven MIT students spent their junior year in Cambridge, four of whom were from the Department of Mechanical Engineering. It was a tremendously enriching year for the Course II students: Kristen Clements, Gina Kim, Kevin Lang, and Linus Park. In addition to being able to transfer a full year of academic credit back to MIT, they immersed themselves in the traditional rituals of College life, participated in the rich musical and athletic programs of the University, and traveled widely within Europe. As a result of this positive experience, the pilot program will turn into a full-scale student exchange this coming year.

Another new activity which the department has been involved in this past year was a "harassment sensitization workshop" which was organized by a diverse group of graduate students, under the leadership of the Mechanical Engineering Graduate Association of Women (MEGA Women). Working with Mary Rowe, the MIT Ombudsperson, they developed an hour-long program of videos and conversation which was attended by over 80 percent of the faculty, staff, and graduate students in the department. According to Mary Rowe, this was a unique event at MIT and a highly successful one.

UNDERGRADUATE PROGRAM

During this past year we have continued to work on our curriculum, instructional pedagogy, and educational facilities. The Designated Professors worked on the core sequences, integrating knowledge in the engineering disciplines, increasing the role of active learning and the hands-on experience, and blending analysis with synthesis.

Professors Mary Boyce, Sanjay Sarma, and Emanuel Sachs implemented a "self-discovery" mode of learning in 2.001 Mechanics and Materials I. Individual experiments are carried out by the students during lecture, enabling the students to discover for themselves the key phenomenon or concept to be studied. Major funding for this initiative came from the I-Campus Program.

The department had a total undergraduate enrollment of 284 students with 34 percent women and 31 percent African American, Hispanic or Native American. Undergraduate enrollment in Mechanical Engineering has been declining worldwide and we have seen this reflected in our own statistics. A major goal for the coming year is to understand the external and internal causes of this decline and to implement changes to reverse this trend at least within MIT.

Table 1. Undergraduate Enrollment

Academic Year	96–96	96–97	97–98	98–99	99–00	00–01
Sophomores	136	126	116	121	106	83
Juniors	120	128	125	117	116	91
Seniors	148	125	121	132	108	110
Total	404	379	362	370	330	284

Honors and Awards

American Society of Mechanical Engineers (ASME) Foundation Scholarships: Collins Pettus Ward and Anastasios John Hart

ASME Garland Duncan Scholarship: Mary Kathryn Thompson

Department Service Award: Emily Hui and Mary Kathryn Thompson

Thomas Sheridan Prize for Creativity in Man-Machine Integration: Aaron J. Schmidt

Padmakar P. Lele Student Awards for Undergraduate Assistants: Tsu-Te Judith Su, Niyati N. Gandhi, Rony Kubat, John M. McBean and Mary Kathryn Thompson

Luis De Florez Awards for Ingenuity and Creativity: Justin W. Raade, Patrick A. Petri, Jonathn D. Rohrs and John M. McBean

AMP Inc. Award for Outstanding Performance in 2.008: Jennifer T. Blundo and Timothy P. McEvoy

Whitelaw Prize for Originality in 2.007 Design: William J. Fienup and Kathy Hwang

International Design Competition Team: Jessica L. Baker, William S. Del Hagen, Alexander T. Jacobs, William Lark, Sarah E. Mendelowitz, and Bryan D. Schmid

Wunsch Foundation Silent Hoist and Crane Awards for Outstanding Undergraduate Project or Thesis Related to Materials Handling: Soohyun Park, Kateri A. Garcia, Christina S. Park, Mark N. Jeunnette, Chunhua Zheng, Grant W. Kristofek, Patrick B. Buckley, and Alison Wong

Pi Tau Sigma Mechanical Engineering Honor Society: Emily Hui (President); Roman Luz (Vice-President); Debbie Redman and Stephanie Praster (Secretaries); Frederico Gutierrez (Treasurer); Patrick Petri and Maria-Louisa Izamis (Tutoring Program Coordinators);

ASME Student Chapter: Collins Ward (President), Kate Thompson (Vice-president), Alex Johnson (Secretary), Jen Blundo (Treasurer).

GRADUATE PROGRAM

Our graduate program continues to be strong with a total of 378 students. Of the 197 students in the Master's program, 30 percent were foreign, 20 percent were women, and 3 percent were minorities. Of the 181 students in the doctoral program 61 percent were foreign, 10 percent were women, and 8 percent were minorities. Our students were supported by 241 Research Assistantships, 25 Teaching Assistantships, 18 National Science Foundation (NSF) Fellowships, 4 Department of Defense (DOD) Fellowships, and 69 other Fellowships.

Table 2. Graduate Enrollment

Academic Year	95–96	96–97	97–98	98–99	99–00	00–01
Masters	208	228	212	220	225	197
Doctoral	191	176	169	172	159	181
Total	399	404	381	392	384	378

This past year 641 students applied for admission to our graduate program; 28 percent of them were offered admission and 56 percent of whom matriculated.

Because of the changing nature of the research interests of our faculty and the field of Mechanical Engineering, a number of new graduate subjects have been developed and are now being successfully offered. These include subjects in molecular modeling, complex fluids, optics, biophysics, internet technology, and information.

In order to keep up with the changing nature of the field, we have also begun to revise our doctoral qualifying examination. In the past the examination areas were limited, more or less, to the mainstream areas of Mechanical Engineering. The possible areas have now been broadened to allow a group of three faculty members to propose a new area for examination as well as a new format. The specific proposals will be made this coming year.

The "Pappalardo Curriculum Development Fund"—an endowment created by Neil and Jane Pappalardo has been supporting a number of undergraduate and graduate book writing projects. At the graduate level these include a book on Biophysics which spans the scales from molecular through cellular to organs, by Professors Grodzinsky, Kamm, and Mahadevan; and a book on environmental fluid mechanics by Professor James Fay. The books will appear in the MIT-Pappalardo Series of Mechanical Engineering Books. The first book in this series, *Axiomatic Design: Advances and Applications* authored by Professor Nam P. Suh appeared this year.

Honors and Awards
Department Service Award: Ephrat Most and Maribel Vazquez

Carl G. Sontheimer Prize for Creativity and Innovation in Design: Matthew Sweetland

The student organization of Mechanical Engineering graduate women, MEGAWomen, has been very active this year, having organized numerous social events for female and male students, as well as qualifying examination preparation sessions and a harrassment sensitization program. The officers of MEGAWomen were Ephrat Most and Maribel Vazquez (co-Presidents).

FACULTY NOTES
Tenure was granted to Professors Seth Lloyd and Peter So.

Professors David Cochran and Anna Thornton were promoted from Assistant to Associate Professor.

Professors Jung-Hoon Chun and Gareth McKinley were promoted from Associate to Full Professor.

Professor Nicolas Hadjiconstantinou was appointed the Rockwell Assistant Professor.

Professor Douglas Hart was appointed the d'Arbeloff Associate Professor.

Professor Emanuel Sachs was appointed the Fred Fort Flowers and Daniel Fort Flowers Professor of Mechanical Engineering.

Professor Rohan Abeyaratne was appointed Head of Department effective July 1, 2001.

Martin Culpeper joined the department as Assistant Professor of Mechanical Engineering. He received his B.S. in Mechanical Engineering from Iowa State University and his Ph.D. from MIT. His field of specialty is Precision Design.

Sang-Gook Kim joined the department as Associate Professor of Mechanical Engineering. He received his B.S. in Mechanical Engineering from Seoul National University and his PhD from MIT. He came to us after having led the development of a reflective imaging technology at Daewoo Electronics Company. His field of speciality is the design and manufacture of devices at the nano- and micro-scales.

Professors Anna Thornton and Taiqing Qiu resigned from the department.

Professor Ali S. Argon retired from the department. He was a leader in the field of materials and brought much recognition to MIT through his many pioneering contributions.

Professor L. Mahadevan was elected to be the first Schlumberger Professor of Complex Systems at Cambridge University. He is on leave from MIT.

Professor Nam P. Suh received an honorary doctoral degree from the Royal Institute of Technology in Stockholm, Sweden. He was also awarded the Mensforth International Gold Medal of the Institution of Electrical Engineers of the United Kingdom; and the first Hills Millennium Award of the Institution of Engineering Designers of the UK.

Professor John Heywood was elected to the American Academy of Arts and Sciences.

Professor Douglas Hart received ASME's Robert T. Knapp Award.

Professor L. Mahadevan won the Society of Engineering Science Young Investigator Award.

Professor Mary Boyce was selected as a MacVicar Faculty Fellow.

Professor Seth Lloyd was awarded the Edgerton Prize.

Professor Triantaphyllos Akylas received a Ruth and Joel Spira Teaching Award.

Professor Forbes Dewey received the Soderberg Award for service.

Professor Sanjay Sarma received the Den Hartog Distinguished Educator Award.

Professor Ahmed Ghoniem was elected a fellow of ASME.

Professor Steve Dubowsky was elected a fellow of the Institute of Electrical and Electronics Engineers (IEEE).

Professor Nam P. Suh published the first book in the MIT-Pappalardo Mechanical Engineering Series entitled *Axiomatic Design: Advances and Applications.*

Professor K. Jurgen Bathe organized the very successful "First MIT Conference on Computational Fluid and Solid Mechanics."

The following members of staff were also recognized. The Caloggero Award for service went to Leslie Regan and Peggy Garlick. Four of the Institute's Infinite Mile Awards went to Maggie Beucler, Marion Gross, Joan Kravit, and Leslie Regan.

More information about the Department of Mechanical Engineering can be found online at http://me.mit.edu/.

Rohan Abeyaratne

DEPARTMENT OF NUCLEAR ENGINEERING

US News and World Report again rated the Department of Nuclear Engineering number one in its field. The consistency of this ranking over many years has reflected the quality of scholarship by students and faculty in the department.

At the beginning of this academic year, the Center for Advanced Nuclear Energy Systems (CANES) was established in a joint effort with the MIT Energy Laboratory under the direction of Professor Mujid Kazimi, the Tokyo Electric Power Company Professor of Nuclear Engineering. The center's research programs will focus on advanced reactor and fuel cycle options that promote the economics, safety, and environmental aspects of nuclear energy. Dr. Pavel Hejzlar was appointed a program director for advanced reactors at CANES. CANES held an Independent Activities Period (IAP) seminar series on new directions for nuclear energy that included 8 lectures. In April, CANES held an international symposium on the role of nuclear energy in a sustainable environment that included 18 speakers and was attended by about 60 people.

In the area of radiation science and technology (RST) there has been an enormous growth of research in quantum information processing. Professor D. Cory heads this activity in the department. It has attracted large funding, a large number of students, and a large number of the best and brightest researchers at MIT and nationwide. Professor Cory is leading the experimental progress using Nuclear Magnetic Resonance (NMR) techniques. A second area of research that is expected to have a large impact involves the nearly completed construction of a new micro-beam accelerator. Professor J. Yanch leads this effort. This facility has the remarkable capability of delivering a single charged particle (e.g., a proton) to a particular part of a single biological cell, thereby allowing for the first time the possibility of a first principles understanding of the interaction of radiation with biological materials. There are only two such facilities currently operating in the US at present.

Research in the fusion area is still dominated by the Alcator C-Mod tokamak led by Professor I. Hutchinson. This experiment is one of the leading experiments in the U.S. and, indeed, the international fusion program. Its focus continues to be in the areas of advanced tokamak physics and plasma-boundary interactions. Results obtained from Alcator C-Mod will have an important impact on the appropriate path for the U.S. fusion program with respect to a next generation, billion-dollar class, burning plasma experiment.

Professor Hutchinson spent the spring semester on sabbatical at the Australian National University as a Visiting Fellow in the Plasma Research Laboratory of the Research School of Physical Sciences and Engineering. He carried out experiments on the Heliac facility there studying the induction of plasma rotation using an internal biassing electrode.

UNDERGRADUATE PROGRAM

Eighteen students were enrolled in the undergraduate program during the past year, including 5 sophomores, 9 juniors, and 4 seniors. Two students completed requirements for the bachelor's degree in nuclear engineering.

Undergraduate curriculum development focuses on strong fundamentals with hands-on experiences in all aspects of nuclear science and engineering applications from energy, accelerators, medicine, research and policy. Two new courses are being developed by Professors Cory and Kadak in neutron science, reactor physics, and engineering of nuclear systems.

GRADUATE PROGRAM

The graduate program totaled 120 students during the fall term. Of this number, 25 were enrolled for their first term. Forty-four percent are specializing in radiation science and technology; 38 percent are working in fission and energy studies, and 18 percent in fusion. The department awarded 17 masters and 20 doctoral degrees during the academic year.

Professors Driscoll and Kazimi offered an expanded version of their course 22.351, Systems Analysis of the Nuclear Fuel Cycle. The course covered various aspects of the in-core and out-of-core aspects of the fuel cycle and their impact on the economics, waste and proliferation-resistance of the fuel cycle. The expanded course included a special computational laboratory in which the students used four state of the art codes for reactor physics and

thermal hydraulics to evaluate the benefits and costs of alternative fuel arrangements in the core, including thorium based fuel and a wide range of moderator to fuel ratio.

In Professor Czerwinski's class, 22.76 Nuclear Chemical Engineering, students performed plutonium-uranium separations with reactor irradiated materials.

FACULTY HONORS, AWARDS, AND ACTIVITIES

Professor Freidberg served as chairman of the Nuclear Engineering Department Head's Organization (NEDHO) this past year. He also continues to serve as a member of the Fusion Energy Sciences Advisory Committee (FESAC). As part of his FESAC responsibilities, Professor Freidberg served as chairman of two important panels. One panel involved the decision as to whether the U.S. fusion program should proceed with a new $60M class stellarator proof-of-principle experiment. The second panel, still in the midst of its deliberations, involves the determination of the proper U.S. strategy with respect to a next generation burning plasma experiment.

Professor Michael J. Driscoll received the Ruth and Joel Spira Award for Distinguished Teaching. This award acknowledges the tradition of high quality engineering education at MIT.

Professor George Apostolakis was elected Chairman of the Advisory Committee on Reactor Safeguards of the U.S. Nuclear Regulatory Commission effective January 1, 2001. He continues to serve on the International Nuclear Technology Committee that advises the governments of three German states (Baden-Wurttemburg, Bavaria, and Hesse) on nuclear technology matters. He gave the keynote address at the International Conference on Probabilistic Safety Assessment and Management (PSAM 5) in Osaka, Japan, on November 27, 2000. He continues to serve as the Editor-in-Chief of the international journal *Reliability Engineering and System Safety.*

Professor Hutchinson was elected a Fellow of the Institute of Physics (UK). He continues as honorary editor of *Plasma Physics and Controlled Fusion.* He chaired a plenary session at the European Physical Society conference on Controlled Fusion and Plasma Physics and gave an invited lecture at the International Symposium on Fusion Engineering.

Professor Kazimi served as the Chairman of the MIT Research Reactor Safeguards Committee. He continues to chair the Hanford Waste Tank Advisory Panel (TAP) for the U.S. Department of Energy (DOE)-Richland that he has chaired since 1990. In April 2001, he gave an invited talk at the ninth International Conference on Nuclear Engineering (ICONE) in Nice, France on spent fuel management.

Professor Todreas was selected to give the inaugural Distinguished Lecture in Nuclear Energy by the department of Mechanical and Nuclear Engineering of the Pennsylvania State University in March, 2001. He was also appointed by the Department of Energy as Co-Chairman of the Advisory Committee for the Development of the Technology Roadmap for Advanced Generation IV Nuclear Energy Systems. His service continues on the National Nuclear Accrediting Board for operating nuclear reactor training programs.

Professor Todreas and three former students, one being Dr. Pavel Hejzlar, a current scientist in CANES, co-authored a second edition of the book *Safety Features of Operating Light Water Reactors of Western Design*, published this year.

Professor Czerwinski was a visiting professor at the organic chemistry group and nuclear science group at Conservatoire National des Arts et Métiers, Paris for five weeks. This visiting professor position also involved teaching at Ecole Nationale Superieur de Chimie de Paris and actinide research with CEA in Saclay. Professor Czerwinski made three invited presentation on his research during the visiting professor position: "The Important Role of Speciation in Pu Waste Management" to COGEMA, in Marcoule, France; "Removal of Pu from Contaminate Sediment with Ozone and Ligands" at the University of Lyon; and "Selective Removal of Actinides with Templated Resins" at the Conservatoire National des Arts et Métiers, Paris.

Professor Czerwinski completed his committee work for the National Research Council committee on Selecting Long Term Research Plan for the Deactivation and Decommissioning of Department of Energy Sites.

In July 2001, Professor Czerwinski will be a visiting instructor on actinide chemistry for the Department of Energy Radiochemistry Summer School at Brookhaven National Laboratory.

Professor Czerwinski made two invited lectures on radioactive waste in the environment, "Transport of Pu by Clay Colloids" at NELRAD 01 held by Northeastern University and "Actinide Speciation for Waste Disposal" for the Air Force Radioactive and Mixed Waste Office at Brooks Air Force Base (AFB), Texas.

Professor Sidney Yip has continued to be active in materials modeling research in several ways: leading the atomistic simulation of materials group in the department which interacts with faculty colleagues and their groups in several other departments across the Institute; organizing two conferences, Symposium on Multiscale Materials Modeling, International Union of Materials Research Societies, Hong Kong, July 2000, and the Annual Meeting of Division of Computational Physics, American Physical Society, MIT, June 2001; and presenting invited talks at a number of national and international conferences, the latter being in Italy, Japan, and Greece. He inaugurated a summer course on atomistic simulations in materials processing at the National Tsinghua University in Taiwan. He is serving on the advisory boards for two directorates at the Lawrence Livermore National Laboratory, Physics and Advanced Technologies, and Chemistry and Materials Science.

Professor Yip accepted a secondary appointment in the Department of Materials Science and Engineering beginning in September 2000.

Dr. Richard Lanza was elected a member of Institute of Electrical and Electronics Engineers (IEEE) Nuclear Science Radiation Instrumentation Steering Committee He is an external expert on the International Atomic Energy Agency (IAEA) Regional Technical Cooperation Project on Humanitarian Demining and Technical Advisor, IAEA Cooperative Research Program on Bulk Hydrogen Measurement.

Professor Gordon L. Brownell received the Bernard H. Falk Award from the National Electrical Manufacturers Association (NEMA) at its 74th Annual Meeting in Chicago on November 13, 2000 for his development of positron imaging and positron emission tomography (PET). NEMA consists of leading executives from major companies active in development of new systems including imaging systems and in the establishment of standards. Professor Brownell and colleagues at MIT and Massachusetts General Hospital (MGH) developed the first positron imaging device for medical application in 1950 and have subsequently designed and built a number of systems including the first PET scanner in 1970. All of these systems have been placed in operation at MGH and some are still providing useful images for biological and medical research. PET imaging has proven to be very useful in identifying the nature of degenerative brain disease such as Parkinson and Alzheimer's diseases and in developing palliative measures. Studies in heart and cancer have also been highly successful.

The PAI Outstanding Teaching Award (awarded by the student chapter of the American Nuclear Society) was presented to Dr. Katherine Held, a lecturer in nuclear engineering.

RESEARCH

Fission

Professor Hansen and Professor Kazimi are leading a project investigating and modeling the processes by which nuclear energy policy is created and modified in industrialized democracies. The initial effort has been to create a "mapping" of the flow of cause and effect through the social/political system and then create quantitative representations of the actual processes. If successful the research will allow for nondestructive evaluation of various energy policies, including providing insight into how to shape the process so as to produce desirable outcomes

The award of a new Nuclear Energy Research Initiative (NERI) project expanded Professor Kazimi's program on advanced nuclear fuel cycles on the heterogeneous thorium-uranium Light Water Reactor (LWR) cores. This is in addition to the NERI awarded the year before on the homogenous thorium-uranium cores and the Idaho National Engineering and Environmental Laboratory (INEEL) supported project on the advanced fuels for Light Water Reactors.

A five year agreement for research collaboration with Tokyo Electric Power Company (TEPCO) was initiated with three projects: determinants of nuclear energy form a social-political context under the guidance of Professor Kent Hansen; modeling of thermal striping at piping joints under the guidance of Professor Kazimi; and improving the

operations of nuclear power plants using risk-based information under the guidance of Professor Apostolakis. An earlier project on risk assessment of seismic events continued under the guidance of Professors Apostolakis and Golay.

Professor Neil Todreas is principal investigator for the following two-advanced nuclear reactor conceptual design projects. The first is a low power rating modular light water reactor being developed by an international consortium of industry, laboratory, utility, and universities led by Westinghouse and sponsored by the U.S. DOE's Nuclear Energy Research Initiative Program. The second is a large power rating lead-bismuth eutectic cooled fast spectrum reactor aimed at both low electricity production cost and actinide destruction being designed in collaboration and with the sponsorship of the Idaho National Engineering and Environmental Laboratory.

Under the supervision of Professor Ronald M Latanision graduate students and postdoctoral fellows of the H.H. Uhlig Laboratory focused their research on supercritical water, a remarkable vehicle for the destruction of chemical wastes such as those generated in both military and civilian enterprise. While one school of research considers the use of noble metal liners as the means of providing corrosion resistance in reactors, we have focused on the use of more traditional corrosion resistant engineering alloys that are protected from corrosion by means of control of the in-reactor water chemistry. High temperatures-high pressure reference and pH electrodes are required to provide such control. Work is underway to demonstrate that this approach can be made practical for industrial service.

Professor Andy Kadak's conceptual design work continues on the modular pebble bed reactor (MPBR). Students are actively engaged in core neutronics and safety analysis. A state of the art fuel performance model for coated particle microsphere fuel is being developed under the guidance of Professor Ballinger. Advanced modularity concepts are being developed to allow for factory manufacture and site assembly that, if successful, could revolutionize how nuclear plants are built. Cooperative international benchmarking activities are proceeding through the International Atomic Energy Agency on an operating pebble bed plant in China and the proposed plant in South Africa. The conceptual design of the MIT version is at a point where design details of the balance of plant are being developed for the components. MIT's pebble bed reactor project is getting a great deal of media attention, *Wall Street Journal*, *Boston Globe*, *Popular Science*, *Washington Post*, radio and television. Professor Kadak was asked to present his "license by test" strategy for licensing advanced reactors to the Advisory Committee on Reactor Safeguards in June. Heather MacLean, a graduate student working on the project, testified before the Senate Subcommittee on Energy and Natural Resources on the need for more incentives for graduate student enrollment in nuclear science and engineering.

Professor Czerwinski continued investigating the speciation of neptunium in spent nuclear fuel supported by DOE-NERI funds. This project is in cooperation with Argonne National Laboratory. The project has initial results on neptunium interaction and speciation in the repository near field.

A joint project with Ecole Nationale Superieur de Chimie de Paris (ENSCP), Conservatoire National des Arts et Métiers, Paris, and Los Alamos National Laboratory investigates lanthanide and actinide separations. Templated ion specific resins for uranium and thorium have been synthesized. The project is supported by the Presidential Early Career Awards for Scientists and Engineers (PECASE) award.

Through a University Research Collaboration (URC) project on Th fuel headed by Professor Kazimi, investigations on the behavior of Th fuel in a repository are continuing. Students Virginia Curran, Wendy Rattray, and Yoann Severstre examined the solubility of thorium oxide and synthesized ceramics with thorium and uranium. Synchrotron studies with Lawrence Livermore National Laboratory have been made on the ceramics.

With Professors Kazimi and Todreas, a project on the release of radioactive polonium compounds from a hot lead-bismuth melt is investigated. The goal is to explore the feasibility of a direct contact heat transfer heavy liquid metal cooled fast reactor for actinide burning and power production. Particular emphasis is given to the study of the chemistry of polonium hydride, which plays a key role in the transport of the radioactive aerosols.

The development of effective soil washing techniques for the removal of actinides, primarily plutonium and americium, from contaminated soil examined the impact of ozone.

Radiation Science and Technology

Professor Sow-Hsin Chen and his graduate student Ciya Liao have formulated a theory for analysis of newly developed high resolution Inelastic X-ray Scattering (IXS) spectra from supramolecular assemblies and have applied this theory successfully to IXS spectra taken from model lipid bilayers. They were able to obtain the in-plane phonon dispersion relations in both the gel and liquid crystalline phases of the bilayer for the first time, thus opening up a new field of studying molecular scale collective dynamics in biomaterials. The result was reported in the January 22 issue of the *Physical Review Letters*, 2001. For this work, Professor Chen was an invited speaker to the annual meeting of the Italian Physical Society, Condensed Matter Section, June 18–22, 2001 in Rome, Italy.

Professor Cory and his colleagues continue to make advances in the theory, practice and implementation of quantum information processing. Over the past year this has included the first exploration of decoherence control via noiseless subsystem encoding, and the first NMR demonstrations of entanglement transfers and quantum erasers.

Quantum Information Processing

Professor Cory and his students continue to explore NMR approaches to quantum information processing through a set of collaborations with Dr. T. Havel (Nuclear Engineering Department [NED]), Professor Seth Lloyd (Mechanical Engineering), Professor Eddie Farhi (Physics), Dr. Raymond Laflamme (Los Alamos National Laboratory [LANL]), Dr. E. Knill (LANL), and Dr. J. Yepez (Air Force Rome Laboratory [AFRL]). Our liquid state NMR implementation of quantum information processing is now being implemented at the 10-qubit level. A complexity far beyond other approaches to quantum information processing.

We have started to construct a new scheme for extending the success of NMR approaches to Quantum Information Processing (QIP) to larger systems via a solid state device capable of coherently controlling 10–30 qubits. This is essential for exploring quantum error correction. We have also obtained funding to explore lattice gas computations on classically distributed quantum computers.

Nuclear Magnetic Resonance of Heterogeneous Semi-solids

In collaboration with Dr. S. Singer and Dr. Pabitra Sen of Schlumberger Doll Research Laboratory we have continued to explore the structure and fluid dynamics of complex media. This has led to a new prognosticator of tumor grade for soft tissue sarcomas, and a new measure of local organization for heterogeneous samples. For the first time the effects of motion can be cleanly separated from the overall spin dynamics, which provides a simple and direct means of characterizing micron scale structures.

Nuclear Magnetic Resonance Imaging of Neuron Structure and Function

In collaboration with Dr. Alan Jasanoff (a Whitehead Fellow at MIT), the neuron structure and response of blowflies is being explored at high resolution via NMR microscopy. The use of blowflies provides a stable and well-characterized test bed, while simultaneously permitting near cellular resolution in the NMR. The goal of the program is to observe neuron activity in living/functioning tissue with the markers being directly traceable to neuron biochemistry.

Radiation Biology

Professor Jeffrey Coderre joined the department in September, 2000 coming from Brookhaven National Laboratory where he spent many years developing the boron neutron capture therapy (BNCT) program. Professor Coderre's research interests lie in the area of radiation biology, which will strengthen the bionuclear research area within the Radiation Science and Technology group. In January 2001, Professor Coderre was awarded a grant from the David Koch Cancer Research Fund entitled "Charged-Particle Microbeam Irradiations of Prostate Tumor Spheroids: A Micrometastasis Model." Professor Coderre is working with Professor Yanch on this project to use the accelerators in the Laboratory for Accelerator Beam Applications for development of a tumor micrometastasis model that allows the quantitative analysis of the effects of localized deposition of alpha particle radiation. This system will model radioimmunotherapy, where alpha-emitting nuclides attached to monoclonal antibodies are delivered non-uniformly to the surface of a tumor metastatic site, and will allow systematic studies on ways to improve prostate tumor therapy.

In July 2001, Professor Coderre was awarded a grant from the DOE Office of Biological and Environmental Research entitled "Mechanisms of High-LET Radiation Damage in Normal Lung." Co-workers on this grant include Professor Otto Harling, Dr. Peter Binns, and Dr. Kent Riley of the MIT Nuclear Reactor Laboratory. This project

will measure the sensitivity of the normal lung to the mix of radiations produced during BNCT and will investigate the possible application of BNCT for treatment of lung tumors. The project will also investigate the mechanisms by which radiation causes damage in the lung and will explore possible biochemical approaches to reduce these side effects.

Coded Aperture Imaging for Nuclear Medicine

As a result of a research project for contraband detection, we have developed a new nuclear medicine imaging technique which has improved the spatial resolution and sensitivity of radioisotope imaging and has opened up new areas, particularly in small animal imaging and other applications where high spatial resolution and sensitivity are required. Patents have been applied for the technique and we are expanding our research effort in collaboration with researchers at the MGH Molecular Imaging Research Center, and at the Radiology Departments of Beth Israel and Brigham and Women's Hospital.

Contraband Detection

We have developed two new methods for the determination of elemental composition of materials in bulk. One uses prompt neutron activation and imaging of the emitted gamma rays, and the other uses neutron resonance radiography. We have an active collaboration with researchers in South Africa at the University of Witswatersrand and at deBeers. Both techniques have shown promise for industrial applications as well and we have applied for patents. This work is sponsored by the Federal Aviation Administration and the Office of National Drug Control Policy.

Intense Neutron Sources

In collaboration with Lawrence Livermore Laboratory and Brookhaven National Laboratory, we have developed a windowless gas target, which permits the operation of pressurized gas targets without intervening windows. In addition to this application, we have been investigating its use for electron beam welding. The use of such a window would permit electron beam welding of large objects without the requirement of their being in a vacuum. The DOE sponsors this work.

Professor Otto Harling has continued his research in neutron capture therapy for cancer. During the last year a major new epithermal neutron irradiation facility (FCB) was completed. The neutron beam is based on a fission converter source, the first time this approach has been used for this purpose. The FCB has high intensity allowing irradiations to be completed in a few minutes. Beam purity is near theoretical optimum, which results in a doubling of the therapeutic ratio compared to the earlier irradiation facility. This medical irradiation facility is currently the best in the world for neutron capture therapy. Preparations are now in progress to begin clinical studies with the FCB. Clinical trials as before will be the responsibility of collaborating medical researchers from the Beth Israel Deaconess Hospital.

Fusion

The Alcator C-Mod Experiment

Under the direction of Professor Ian Hutchinson, the Alcator C-Mod tokamak continued its studies in high-performance, compact magnetic plasma confinement. The upgrade to permit quasi-steady-state exploration of Advanced Tokamak operation with high fractions of self-generated current is proceeding well under the leadership of Professor Ronald Parker. It should be completed in about 18 months. In the subsequent plasma operations we will attempt to demonstrate the feasibility of steady-state tokamak operation attractive for future reactor application.

The phase-controlled antenna for RF heating, installed as part of a collaboration with Princeton Plasma Physics Laboratory, has been further upgraded. It now heats well without major undesirable side effects. However, so far it has not proven possible to drive significant plasma current with it. Establishing the reasons for the performance limitation is an important research topic since heating and current drive of this type is proposed for future major fusion experiments.

Plasma rotation studies of the spontaneous plasma spin up continue to provide insights into tokamak anomalous transport and its suppression. An internal transport barrier effect has been discovered. Particle diffusion is strongly reduced when heating the plasma approximately half way out. The resulting peaking of the density profile is accompanied by a strong decrease of the core rotation.

The high-resolution measurements of the sharp edge of the plasma are showing remarkable structure in the transport barrier and indicate that additional physics beyond ideal magnetohydrodynamics is essential to explain its stability. Under some circumstances on Alcator C-Mod the particle confinement of this edge transport barrier is reduced, allowing the density and impurities to be controlled. The specific instability that is responsible for this favorable mode of operation has been characterized further and it has been demonstrated by short-range magnetic probing that it possesses a strong magnetic, as well as electrostatic component. The favorable operational characteristics observed on Alcator have spawned a number of activities on other research tokamaks to demonstrate similar benign particle control.

Levitated Dipole Experiment

The Levitated Dipole Experiment (LDX) represents a new concept exploration experiment funded by the DOE and was initially funded as a five-year research grant. LDX is a joint collaborative project with Columbia University and it will be located in NW21 at MIT. The principal investigators of this project are Dr. Jay Kesner of MIT and Professor Michael Mauel of Columbia University. The LDX facility is being designed by the engineering division of the Plasma Science Fusion Center (PSFC) under the leadership of Dr. J. Minervini.

When completed LDX will be the only superconducting magnetic confinement experiment in the American fusion research program. The design of the facility was largely completed during FY1998, and we are now in the construction phase. The vacuum chamber is in place in the Tara cell of NW21. The high performance Nb_3Sn floating coil has been successfully tested and the cryostat is nearly complete. The high-TC levitation is expected to be completed by October 2001. The NbTi charging coil is expected to be arriving at MIT in December 2001. The first plasma results are expected in the spring of 2002.

The levitated dipole experiment represents a new and innovative approach to magnetic fusion, which will utilize a levitated superconducting coil to confine plasma in a dipole magnetic field. The concept was inspired by the observations of high pressure plasmas and can be confined by planetary dipole magnetic fields, such as the magnetosphere, which surrounds Jupiter. Compared with the traditional fusion approaches the levitated dipole may permit the confinement of higher-pressure plasmas with reduced cross-field transport. The project has been funded as a five-year grant with an approximate annual budget of $1.4 million (shared between MIT and Columbia University). The construction of the project will take place during the initial four-year period.

Plasma Theory

Professor Freidberg and Antonio Bruno, a graduate student, have developed a new theory to predict the anomalous heat transport coefficient observed in Reversed Field Pinches. The basic idea is to calculate steady state profiles assuming the plasma has relaxed to a lowest energy state consistent with being marginally stable to tearing modes.

Professor Freidberg and Mike Thomas, a graduate student, have developed an magnetohydrodynamic (MHD) linear stability code for axisymmetric toroidal geometries including the tokamak. The model treats the ideal MHD model and includes the effect of toroidal equilibrium flow and a resistive wall.

MIT's levitated dipole experiment is nearing completion of its construction phase. One important issue concerns the existence and behavior of large plasma convective cells. Such cells, depending upon their behavior, might have either a favorable or unfavorable impact on heat and particle transport. A project has been initiated by Professor Freidberg, Dr. J. Kesner, and Alexi Kouznetsov, a graduate student, to determine the conditions under which such cells might develop and their resulting impact on transport.

Fusion-Fission Hybrids

Under the direction of Professor Ron Parker good progress is being made toward the goal of achieving the necessary conditions for a net-energy producing fusion reactor that has led to a reexamination of the symbiotic possibilities for fusion-fission hybrids. The concept is not new, having been explored for example in a series of papers by Professor L. Lidsky beginning in the late 1960s. In the present work, two configurations have been considered. The first makes use of the fast neutrons generated by fusion reactions to transmute the minor actinides (MAs) in the spent fuel from present-day light water reactors. The second uses the fusion neutrons to drive a subcritical Thorium blanket.

In the case of the actinide burner, it was found that 2-3 fusion reactors with the general characteristics of the International Thermonuclear Experimental Reactor (ITER) fusion reactor, now under consideration for construction

in Europe or Japan, could transmute the entire annual MA production from the present U.S. fleet of light water reactors. At the same time, the thermal power generated by fission of the MAs in each reactor will be sufficient to generate about1000 MW of electricity.

In the second study, the features of a fusion reactor having the parameters of the present ITER design but partially surrounded with a Th-U233 breeding blanket are being elaborated. Since the fission system is driven by fast neutrons, its performance is insensitive to the buildup of fission products. Consequently, high burnup fractions can be achieved and the time before refueling is required might be extended to 20 years, the latter being determined by material fluence limits rather than the buildup of fission products. A particularly attractive feature of this hybrid concept is the low level of transuranic (TRU) waste that would be generated (e.g., < 1 kg after 30 GW-yr of operation). A high-degree of passive safety is inherent in this concept since the reactor operates far below criticality and the thermal inertia of the fusion system is sufficient to safely limit the thermal response of the system to afterheat.

The work on the actinide burner was carried out by a team of students under the guidance of Professors Golay, Kadak, and Parker, while the design of the Thorium burner was developed by V. Tang, a graduate student, under Professor Parker's supervision.

STUDENT AWARDS AND ACTIVITIES

Extracurricular NED student functions centered on the MIT American Nuclear Society Student Branch. There have been many social and athletic events during the year reflecting the interests of its members. The every other Monday afternoon seminar series, NED orientation for incoming students, the holiday party, and the international dinner are a few of the successful events from the past year.

The MIT Chapter of the Alpha Nu Sigma Society, a national honor society for students in applied nuclear science and nuclear engineering, recognized six graduate students and two undergraduate students for their outstanding academic achievement. The MIT Health Physics Society Student Branch's activities are focused on environmental radiation transport, radiobiology, and radiation detection and measurement.

A number of students were recognized at the annual international dinner/awards ceremony in May 2001.

Antonio Romano received the Manson Benedict Fellowship awarded to a graduate student for excellence in academic performance and professional promise in nuclear engineering.

Twiggy Gi Gi Chan received the Roy Axford Award for academic achievement by a senior in nuclear engineering.

Ian Parrish received the Irving Kaplan Award for academic achievement by a junior in nuclear engineering

Graduate students Karen L. Noyes and Randi J. Cohen shared the Outstanding Student Service Award in recognition of exceptional services to the students, the department and the entire MIT community.

Graduate students Zhiwen Xu and Dean Wang shared the Outstanding Teaching Assistant Award in recognition of exceptional services to education by a teaching assistant.

A graduate student, Wei Cai, in the atomistic simulation of materials group in the department took first place in the competition for the Lawrence Fellow award at the Lawrence Livermore National Laboratory.

On behalf of the Scholarship Policy and Coordination Committee, Heather MacLean received the ANS James F. Schumar Scholarship Award, Christopher Melhaus received the ANS Everett P. Blizard Scholarship Award, Virginia Curran received the ANS John D. Randall Memorial Scholarship Award, and Karen Noyes and Christina Sherman each received the ANS Graduate Scholarship Award.

More information about the Department of Nuclear Engineering can be found online at http://web.mit.edu/ned/www/.

Jeffrey P. Freidberg

DEPARTMENT OF OCEAN ENGINEERING

Perhaps nothing in the Earth's landscape captures our imagination as much as the oceans. Full of mystery, beauty, bounty, and potential, they also represent the last great frontier for exploration on our planet. Since its inception, MIT's Department of Ocean Engineering has been committed to educating exceptional students who will take on this gauntlet of discovery. The field of ocean science is exciting, ever changing, and challenging, as we learn more each year about the critical role of the seas in areas such as climate change, energy, transportation, global economies and nearly every aspect of our lives. In the simplest terms, ocean engineering can be defined as the development of engineering systems for use in the ocean. In the department, students examine the complex phenomena of the oceans and develop novel technologies through intensive, hands-on-research. In so doing, they also gain a knowledge that fosters the wise use and preservation of these irreplaceable natural resources. We have set high goals for ourselves for the 21st century, including designing complex systems for high-performance ocean vehicles; leading the information revolution in the ocean; conducting large-scale experiments to better understand marine environments; and introducing chemistry and biology into the discipline of ocean engineering. Much of this work draws on earlier research in the Department, and much work still lies ahead.

In collaboration with the MIT Sea Grant College Program, the department has revolutionized the design of autonomous underwater vehicles, or AUVs. Such submersibles are now unlocking secrets of the deep oceans for scientists, industry and national defense. We look forward to a future filled with innovation and discovery, with a keen eye always on sustaining our marine environment and economy.

The mission of the department is to: educate and prepare students for leadership positions in industry, government and educational institutions; influence future directions of ocean engineering education and practice; and develop and disseminate knowledge and technology in order to foster and enable the wise and effective use, development and preservation of the ocean, its natural resources and its environment.

The major goals of the department over the next ten years are to: lead the information revolution in the domain of the oceans; lead the application of large-scale, complex system design and engineering for high-performance ocean vehicles and systems; contribute to a better understanding of ocean dynamics through large-scale experiments that complement the theoretical and numerical capabilities presently available; and prepare ground for the next major innovation in the department, which is to introduce chemistry and biology into the discipline of ocean engineering.

ACCOMPLISHMENTS

The Visiting Committee reviewed the department in March 2001 with the faculty and staff presenting its strategic plan and the major goals of the department over the next ten years. The Visiting Committee endorsed our activities and encouraged the faculty to maintain its momentum and excellence in its education and research activities.

For the third year we offered *Discover Ocean Engineering: A Special Introduction to MIT* to the Class of 2004. This innovative program for incoming freshmen was set up in 1998 as a four-day program to provide a first glimpse of what engineering is all about. It also allows the students to become familiar with some of the opportunities that the field of ocean engineering has to offer. In addition they get a jump-start on becoming involved in campus life and building a close relationship between the students, our faculty and staff. As in the past, the agenda consisted of hands-on experience building a small remotely operated vehicle (ROV), testing it in the water, and providing a chance to perform some actual research experiments with an ROV in Boston Harbor. This pre-orientation program, supplemented by funding of $12,000 through the Dean's Office of the School of Engineering, remains extremely popular and we already have 30 students signed up for the summer 2001 Discover Ocean Engineering.

In October 2000, Dr. Eliot G. Drucker, presented the sixth annual T. Francis Ogilvie Young Investigator Lecture on "How Fish Swim: Functional Insights from Experimental Wake Visualization." Dr. Drucker is a postdoctoral researcher at the University of California, Irvine in the Department of Ecology and Evolutionary Biology.

The winner of the 2001 Robert Bruce Wallace Prize, which is awarded to an outstanding undergraduate in the Department of Ocean Engineering, was Karl-Magnus W. McLetchie. Karl was selected from a list of extremely qualified candidates and will be provided a full academic year of tuition and stipend for FY2002.

The following individuals were awarded the Martin A. Abkowitz International Fellowship: Dr. Todd Taylor for his participation in the Waterjet Propulsion III conference sponsored by the Royal Institution of Naval Architects held in Gothenburg, Sweden in February 2000; and Dr. Clifford Whitcomb for his participation in the International Symposium of the International Council on Systems Engineering (INCOSE) to be held in Melbourne, Australia July 1–5, 2001. Dr. Whitcomb will represent the Department of Ocean Engineering as a designer of complex systems.

Normally on an annual basis we hold the Ship Design Symposium to showcase the work of our faculty and XIII-A students and to foster positive communications between academia, industry and the Navy and government on issues relevant to Naval Construction and Engineering. This year we took the opportunity to hold the Ship Design Symposium in conjunction with the Naval Construction and Engineering Course XIII-A's 100th anniversary celebration. A number of activities were planned which allowed participants to mingle and renew old acquaintances

and forge new ones. A panel discussion on "Maintaining Technological Supremacy—Future of Ship Design Education and Research Opportunities" included RADM Jay M. Cohen, Chief of Naval Research, Millard Firebaugh, (RADM USN ret) Vice President of Advance Development, General Dynamics/Electric Boat Company, RADM (select) Paul Sullivan, Program Manager VIRGINIA Class Submarine, Professor Harvey Sapolsky, Director of MIT Security Studies, and Professor Chryssostomos Chryssostomidis, Department Head, Ocean Engineering and Director of Sea Grant. President Charles M. Vest was the evening dinner speaker along with Admiral Frank (Skip) Bowman, Director of Naval Nuclear Propulsion. On the following day faculty and students presented a variety of research projects on which they were working. Naval Sea Systems Command (NAVSEA) provided funding towards preparation of the brochure and folders; General Dynamics, Office of Naval Research (ONR) and the Dean's Office provided additional funding towards the conference itself. Overall the event was extremely successful.

Our 21st annual Alumni Reunion was held at the Pan Pacific Hotel in Vancouver, British Columbia, Canada on October 5, 2000. Professor Chryssostomos Chryssostomidis served as the host at the reception which was well attended by alumni, faculty, and guests. The reunion is held annually in conjunction with the Society of Naval Architects and Marine Engineers Annual Meeting.

ADMINISTRATIVE CHANGES

Our Student Administration Office has undergone some recent changes. In addition to expanding into larger quarters, we underwent a staff change as well. Jean Sucharewicz moved to Maryland and Katharine de Zengotita was hired as her replacement as Student Administrator. Tammy Lynch was hired to fill the administrative assistant position when Beth Tuths transferred to Chemical Engineering.

We continue to teach 13.10J (1.573J) Structural Mechanics with the Department of Civil and Environmental Engineering. In addition we also teach 13.002J (10.002J) Introduction to Numerical Analysis for Engineering with the Department of Chemical Engineering.

As the result of an extensive search for a new faculty member in the area of hydrodynamics, Dr. Alexandra Techet, a former MIT Ocean Engineering student, was hired as the department's newest junior faculty member. Alex will begin her appointment July 2002.

During the spring of 2000, Professor Sclavounos chaired a committee which looked in depth into the structure of the OE part I doctoral Qualifying Exams. The committee carried out discussions on the scope, breadth and depth of the current exam requirements, studied the structure of the Part I Qualifying Exam in most other departments in the School of Engineering and recommended the restructuring of the exams. The committee recommendations were discussed extensively with the faculty and were voted into effect starting with the January 2001 Doctoral Exams.

The department received funding from the Dean's Office of the School of Engineering to assist in the upgrading of the Towing Tank under the direction of Professor Michael Triantafyllou and for providing state-of-the-art equipment in the Ship Design Computer Laboratory. In addition, the department provided matching funds.

The Navy XIII-A Design Lab was refurbished with new computers and furniture along with the installation of a CAD ship design tool to provide a more effective working space for naval graduate students.

FUTURE PLANS

Professor Michael Triantafyllou will complete the development of the web-based class 13.49 Maneuvering and Control of Surface and Underwater Vehicles. He is also planning on writing a new book on maneuvering in collaboration with Dr. Franz Hover.

Professors John Amy and Michael Triantafyllou along with Dr. Franz Hover have started working on the development of a new subject that will introduce students to the concept of an all "electric ship." This concept promises to revolutionize ship design and have an impact of equal magnitude as did the introduction of steam at the turn of the century which replaced sails.

PERSONNEL INFORMATION

Departmental Awards and Activities

CDR John V. Amy, USN replaced LCDR Clifford Whitcomb, (USN Ret.) as Associate Professor of the Practice of Naval Construction and Engineering

Professors Arthur B. Baggeroer and Nicholas C. Makris continued their third year in the positions of Secretary of the Navy/Chief of Naval Operations (SECNAV/CNO) Chair and Scholar, respectively. Each award includes four years of support for one Research Chair and associated Scholar.

Dr. David Burke, with the assistance of Erik Millet, support staff, and Christine Salib, an independent contractor, are in the process of upgrading the Ocean Engineering web page.

Professor Chrys Chryssostomidis was the Chief Scientist of a ten-day expedition to Nisyros, Greece. Autonomous Underwater Vehicles (AUVs) were used to explore the ocean bottom for archaeological artifacts. To the best of our

knowledge this is the first major cruise using AUVs dedicated to marine archaeology. During the Nisyros expedition, the ocean bottom near Nisyros was mapped using side-scan sonar and was successful in imaging a medieval wreck of porcelain plates. Our long-term research objective is to ground truth side-scan sonar records with visual images and start building a library of sonar targets with visual comparisons that will help future explorers identify interesting targets.

Professors Justin E. Kerwin and Koichi Masubuchi, although retired, remained on 49 percent appointments and completed their final year of teaching and student supervision.

Professor John Leonard was appointed Accreditation Board for Engineering and Technology (ABET) coordinator for the Department of Ocean Engineering. Our challenge from ABET is to demonstrate that students have "the ability to work in groups to perform engineering design at the system level, integrating multiple technical areas and addressing design optimization."

Professor Nicholas C. Makris won the Henry L. and Grace Doherty Professorship of Ocean Utilization in July 2000 for his project "Monitoring Natural and Manmade Ambient Noise in Massachusetts Bay." This is a two-year professorship providing an annual budget of $25,000.

Professor Hank Marcus was appointed to the 26-member Marine Transportation System (MTS) National Advisory Council which advises the Secretary of Transportation on matters related to the marine transportation system.

Prior to his retirement, Professor Koichi Masubuchi and the department created a new fund account entitled "The Koichi and Fumiko Masubuchi Fund" to promote the publication or dissemination of information dealing with the applications of scientific principles and analytical understanding with emphasis on ocean and related engineering disciplines. Preference will be given to the dissemination of information resulting from Japanese and American scholar collaboration in these disciplines.

In honor of Professor Koichi Masubuchi, a welding research and engineering festschrift (proceedings of a conference) has recently been published. This festschrift commemorates Professor Masubuchi's career which has had a profound influence on contemporary science and engineering practices.

Professors Chip McCord and Cliff Whitcomb organized and conducted successfully seven short courses over a nine week period for the Professional Summer Program to meet unique Navy educational needs that cannot be met on-campus during the regular academic year.

Professor Nicholas Patrikalakis served as Chair of the Undergraduate Program Committee.

Professor Henrik Schmidt was elected a member of the Executive Council of the Acoustical Society of America (2000–2003.) In addition, he was appointed Chair of the Graduate Program Committee.

Professor Michael Triantafyllou was on sabbatical leave during the spring term to study the latest theory and technology of underwater ocean exploration. Although based in Athens, Greece, he visited Southhampton, England and Brest, France, among other locations. He also represented all organizations involved in the Nisyros expedition; MIT, National Technical University of Athens (NTUA), the National Centre for Marine Research of Greece (EKTHE), the Marine Archaeological Agency of Greece, and the Ministry of Culture.

Professor Michael Triantafyllou had an article on biomimetic work printed in the August 2000 issue of *Smithsonian*. In addition, there was extensive reference to biomimetic work at MIT in an article in the *Science Magazine*, April 2000.

Professor Kim Vandiver continues with his second year as the Dean for Undergraduate Research. This includes being Director of Undergraduate Research Opportunities Program (UROP) and Director of the Edgerton Center as well as the Co-Director of the Office of Academic Services.

Professor Tomasz Wierzbicki and Dr. David Burke developed and taught for the first time, a new undergraduate subject, 13.019 Computational Techniques for Structural Design. This subject includes completion of four design projects along with the study of basic theory and design of structures.

Student Awards
Xiaoqing Teng received the Rosenblith Scholarship for FY2001.
Katherine Croff, Kwang Lee, Young-Woong Lee, Anna Michel, and Athanasios Denisis each received a one semester Presidential Fellowship.

Katy Croff worked under the supervison of Professor David Mindell, Dibner Associate Professor of the History of Manufacturing and Technology, and under the auspices of MIT's Deep Sea Archaeology research group in last fall's

discovery of well-preserved human dwelling sites at the bottom of the Black Sea. Katy also has a Knauss Sea Grant Fellowship in Washington, D. C.

Matthew Walter and Benjamin Connell both received an American Society for Engineering Education (ASEE) National Defense Science and Engineering Graduate (NDSEG) Fellowship which provides three years of funding towards tuition, stipend and fees.

Philip Taylor completed his final year of an ONR NDSEG Fellowship.

Alexander Kleiman receive the American Bureau of Shipping Fellowship for FY2001.

Ann Marie Polsenberg received the Society of Naval Architects and Marine Engineers (SNAME) Undergraduate Scholarship for FY2001.

Anna Michel was notified that she will receive an NDSEG Fellowship as well as the Link Foundation Fellowship for FY2002.

TEACHING AND CURRICULUM

The Acoustics curriculum has been reorganized so that 13.851 Fundamentals and Applications of Underwater Sound will be offered together with 13.810 Acoustic Sensing in the fall and will include more fundamental acoustics than previously. This will be followed by 13.852 Ocean and Seabed Acoustics which is a modified version of 13.863 Ocean Seismo-Acoustics except that it will now provide a thorough introduction to full-field waveguide propogation. 13.853 Computational Ocean Acoustics, a new subject typically to be taken in the second year will expose the students to all the significant computational approaches to acoustic and seismic waveguides.

The OE Undergraduate Program Committee is in the process of revising the curriculum in the structures area. Together with Professors Patrikalakis, Vandiver, and Wierzbicki and Dr. Burke, extensive discussions have been initiated concerning revision of our entire graduate and undergraduate mechanics, dynamics, structures, material and fabrication curriculum (including considerable exchanges with Course 1 faculty) a process which is still underway. The immediate result has been an agreement with the Department of Civil and Environmental Engineering to co-list 13.013J/1.053J Dynamics and Vibration, and co-list and co-teach 13.014J/1.052J Materials and Structures, each fall, starting with the next academic year.

The integration of computer tools for the 13.412 Principles of Naval Ship Design, and 13.405 Surface Ship Computer-Aided Design, continues, with the incorporation of a product data model and CAD tool for 2000. Professor Whitcomb is working with Parametric Technology Corporation (PTC) to develop their training course for their new Pro/ENGINEER Shipbuilding Solutions system. This CAD package will be used to teach ship design at MIT, and the curriculum will also be used by PTC to teach their software courses worldwide.

RESEARCH ACTIVITIES

The Department of Ocean Engineering recently completed a new program and research brochure which highlights the various programs in the department as well as providing an excellent overview of the research projects being conducted by our faculty and staff. Our gratitude to Dr. Joseph Fischer, Visiting Scientist in the Department of Ocean Engineering for his extensive writing, editing and supervision of this brochure. The department's faculty and staff continued their research in a varied number of programs which continue to receive worldwide attention. Professors Baggeroer and Schmidt continued their work in broadband active and passive matched field processing in shallow water. In addition, Professor Baggeroer was developing a plan for ONR to construct an ocean acoustic observatory, and analyzing the noise field from the five vertical arrays deployed off Monterey, CA for the North Pacific Acoustic Laboratory (NPAL) Coherence and Full Field Processing under ONR support.

Professor Nicholas Makris continues his work in a variety of fields including acoustic detection and classification of hurricanes; spectral formulation for the Doppler-shifted field scattered by an object moving in a stratified medium; reverberation and submerged target scattering in shallow water, geological clutter experiments and a search for an ocean on Europa.

Professor John Leonard continued with the development of decoupled stochastic mapping (DSM) and initiated a new project under funding from Draper Labs for extension of the approach to multiple robot navigation. The goal is for several vehicles to cooperatively perform concurrent mapping and localization (CML). In addition, he is working on real-time implementation of CML onboard an autonomous underwater vehicle (AUV).

Professor Nicholas Patrikalakis together with Dr. Takashi Maekawa, completed development of Praxiteles, (the official US Navy software for the exchange and inspection of marine propellers) further enhancing its utility for inspection and feature extraction. He also continued with Solid Freeform Fabrication (SFF), a major National Science Foundation (NSF) ONR project which has as its objective the development of a generalized solid modeling method for SFF, providing support for design and representation of solids with local composition control (LCC), which is not possible in today's CAD systems. In addition, he also continued with his work on Poseidon: A Coastal Zone Management System over the World Wide Web. Considerable progress was made this past year in the area of

metadata for data, the conceptualization of the metadata problem for software, and in the graphical creation of complex workflows for distributed execution.

Professor Henrik Schmidt's research on the multi-static active acoustics project, his main ONR core funded project, is to develop fundamental understanding of the acoustic environment of the seabed, and to develop new numerical models of the 3-D scattering by seabed objects, such as mines and hazardous waste containers, on and below the seabed in shallow water. Closely tied to the Multi-static Acoustics effort is the Generic Ocean Array Technology Sonars (GOATS), a new system concept for acoustic observations in the ocean environment, replacing the traditional hard-wired hydrophone arrays. This is done by a virtual array of small underwater vehicles, each equipped with a small aperture array, and linked together by high-bandwidth acoustic or optical links. GOATS is envisioned as the enabling technology which with the new 3-D modeling capabilities can be synergized into an entirely new sonar concept for mine counter measures and undersea warfare in shallow water. Professor Schmidt and Dr. James Bellingham have been granted a U.S. patent for this concept.

Professor Michael Triantafyllou completed the second phase of his research project funded by ONR, on the development of a rapidly maneuvering flexible-hull vehicle, the continuation of a previous phase undertaken with IS Robotics to develop a rapidly maneuvering vehicle. The purpose was to develop an industrial-strength fast-maneuvering vehicle named "RoboMuskie." In addition to numerous other research projects, Professor Triantafyllou is also working on a snake-like robotic vehicle under Defense Advanced Research Projects Agency (DARPA) support. The purpose is to develop a flexible-hull robot in the form of a snake combining turbulence reduction and separation control through the transverse motion of its body.

Professor Tomasz Wierzbicki has completed the first three years of his Ultralight Project, Phase I where there were three objectives of the initial 3-year project: to develop efficient computational tools for crash prediction of thin-walled automotive structures reinforced by an ultralight filter; to assess the relative performance of the ultralight structures compared to traditional steel or aluminum components of car bodies from the point of view of their strength, energy absorption, and weight; to develop and optimization technique to minimize weight or maximize energy absorption of a given ultralight structure under certain performance and geometrical constraints. In addition, performance of several new design concepts bringing substantial weight savings such as sandwich sheets was quantified.

Professor Kim Vandiver is currently working on a project with a U.S. Navy student to reduce the injuries to U.S. Navy Seals riding in small high-speed vessels. The injuries result from impacts of the craft with waves, particularly in nighttime operations. He also continues with his vortex-induced vibration (VIV) of cables and risers which is sponsored by ten companies. This project emphasizes the development of response prediction computer programs and the development of new techniques for the suppression of flow-induced vibration. A major accomplishment of this research is the SHEAR7 Version 4.0 software which has been completed. Twenty-five companies plus the ten project sponsors have purchased licenses and are now using the program in their businesses.

More information about this Department can be found online at http://oe.mit.edu/.

Chryssostomos Chryssostomidis

DIVISION OF BIOENGINEERING AND ENVIRONMENTAL HEALTH

The Division of Bioengineering and Environmental Health (BEH) continues to grow in terms of top-quality faculty and student numbers, innovative educational programs, and forefront research programs in pursuing its mission of fostering MIT education and research fusing engineering with biology. Our formal Institute mission statement is "To organize education and research at the interface of engineering with biology, with special emphasis on biomedical engineering, pharmacology, and toxicology." The central premise of BEH is that the science of biology will be as important to technology and society in the next century as physics and chemistry have been in the previous one. Therefore, to translate the revolution in modern biology into a corresponding revolution in biology-based technologies, a new biology-based discipline of bioengineering must be established. We are endeavoring to educate engineers and scientists who can: apply their measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions, or subjected to pathogens or toxins; and apply their design perspective to creating innovative biology-based technologies in medical diagnostic, therapeutic, and device industries, as well as in non-health-related industrial sectors such as agriculture, environment, materials, manufacturing, and defense. This should lead to a new generation capable of solving problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems.

The current BEH faculty members (with other MIT affiliations noted in parentheses) are Peter Dedon, William Deen (Chemical Engineering), Forbes Dewey (Mechanical Engineering), Bevin Engelward, John Essigmann (Chemistry), James Fox (Comparative Medicine), Linda Griffith (Chemical Engineering), Alan Grodzinsky (Electrical Engineering and Computer Science), Neville Hogan (Mechanical Engineering), Ian Hunter (Mechanical Engineering), Roger Kamm (Mechanical Engineering), Alex Klibanov (Chemistry), Robert Langer (Chemical Engineering), Douglas Lauffenburger (Chemical Engineering), Harvey Lodish (Biology), Scott Manalis (Media Arts and Sciences), Paul Matsudaira (Biology), Leona Samson, Ram Sasisekharan, David Schauer, James Sherley, Peter So (Mechanical Engineering), Steven Tannenbaum (Chemistry), William Thilly, Bruce Tidor (Electrical Engineering and Computer Science), Dane Wittrup (Chemical Engineering), Gerald Wogan, and Ioannis Yannas (Mechanical Engineering); in addition, Darrell Irvine (Materials Science and Engineering) will join the faculty this coming year upon completion of his postdoctoral work.

During fiscal year 2001, the sponsored research volume in BEH under the supervision of Administrative Officer Rolanda Dudley-Cowans was $5.8M, representing a 35 percent increase over FY2000. This actually represents only those sponsored projects formally assigned to the Division; most BEH faculty members additionally operate sponsored research projects supervised administratively within other departments and centers; these include the Biotechnology Process Engineering Center, Center for Biomedical Engineering, and Center for Environmental Health Sciences, all of which are directed by BEH faculty members (Douglas Lauffenburger, Alan Grodzinsky, and William Thilly, respectively). The major research areas within BEH include biological and physiological transport phenomena; biological imaging and functional measurement; biomaterials; biomolecular engineering and cell and tissue engineering; computational biology; discovery, design and delivery of molecular therapeutics; genetic toxicology; macromolecular biochemistry and biophysics; metabolism of drugs and toxins; microbial pathogenesis; carcinogenesis; biomechanics; molecular epidemiology and dosimetry; molecular pharmacology; genomics, proteomics, and glycomics.

UNDERGRADUATE EDUCATION

With the formation of BEH in July of 1998, there was created an appropriate academic "home" for the Minor degree program in Biomedical Engineering (BME). This program had been overseen by Professor Roger Kamm via the Center for Biomedical Engineering since the minor's inception in 1995. Immediately upon the establishment of the new division, however, the administration of the Biomedical Engineering (BME) Minor was transferred permanently to the BEH Academic Office.

Moving the BME Minor to a central departmental office has proven to be beneficial. Debra Luchanin, Academic Administrator for BEH, now oversees the administration of the program, and keeps formal records on student enrollment, withdrawal, and completion. In addition, program information has been revised and redesigned.

The BME Minor continues to attract a steady number of undergraduates. One hundred ten were enrolled in the program during 2000–2001 and 35 seniors were awarded the Minor degree at Commencement. Most of the students are drawn from Chemical Engineering, Biology, Electrical Engineering, or Mechanical Engineering.

Generous funding from the Whitaker Foundation has enabled us to establish several Bioengineering Undergraduate Research Awards to be distributed each year, beginning in 1999–2000. Students enrolled in the BME minor receive preference for these awards, which were given to support bioengineering UROP projects. Ten students each received $1,200 of research support during the academic year; an additional six students were each awarded $4,400 of support for their summer 2001 research projects. Biomedical Engineering Society (BMES) members continued to be active; among other activities, they assisted with the Academic Midway and the Pre-Frosh Preview, and created a Student Guidebook.

One issue we have been monitoring about the BME minor has been the rate of actual completion; in its early years of operation, roughly 30 percent of those who enrolled in the minor did not complete the requirements by graduation. We began to track formally the reasons given for withdrawal. The program is certainly one of the most rigorous offered by the Institute, and students most frequently have noted a lack of time to complete all of the required subjects. In order to help alleviate the unusually heavy load, the required Science Core and Bioengineering Core subjects were recently modified to allow for more flexibility, and the total number required was reduced by one. Gratifyingly, the withdrawal rate for the 2001 cohort dropped to 20 percent. The BEH Academic Administrator will continue to monitor the withdrawal rate and to collect information from those who drop the program to determine if there are additional future modifications to be implemented in order to improve the program's retention rate.

A new BEH-administered undergraduate minor degree program—in Toxicology and Environmental Health (TEH)—began accepting formal enrollment in fall 1999. The goal of this new minor is to meet the growing demand for undergraduates to acquire the intellectual tools needed to understand and assess the impact of new products and processes on human health, and to provide a perspective on the risks of human exposure to synthetic and natural chemicals, physical agents, and microorganisms. Given the importance of environmental education at MIT, the program is designed to be accessible to any MIT undergraduate. Requirements include three didactic core subjects, a newly created laboratory subject "Laboratory Fundamentals in Biological Engineering," and one restricted elective. In 2000–2001, nine students, mostly Biology majors, enrolled in the TEH minor; four of those completed the program and graduated in June, 2001. An informational Open House about the TEH minor was held in April and attracted approximately 75 interested students. We eagerly anticipate future enrollment of 20–25 students per class as more students become aware of this program. Additional subjects have been added to the TEH Core and Laboratory course lists in order to provide students with greater choice and flexibility for meeting the TEH minor requirements.

BEH introduced a new academic program in 2000–2001—the Master of Engineering in Biomedical Engineering (MEBE). Designed as a fifth year of study for MIT undergraduates, the MEBE program's main goal is to educate students in the application of fundamental engineering principles to solve challenging problems in biology and medicine. Program requirements include Bioengineering Core subjects, Biomedical Engineering electives, Bioscience electives, and a thesis. Nineteen students applied for admission in the first year, with the majority of applicants from Chemical Engineering and Biology; in addition we received applications from students majoring in Mechanical Engineering, Aeronautics and Astronautics, Materials Science, Electrical Engineering, and Mathematics. Nine applicants were offered admission and seven enrolled in the program. Overall, the applicant pool was quite competitive, with 4.5 being the lowest GPA of the admitted group. Twenty-four students recently submitted applications for enrollment in the coming year. Admission decisions for that class will be made soon and the applicant quality again appears to be quite high.

GRADUATE EDUCATION

The new Ph.D. program in Bioengineering was introduced in fall 1999 with a class of 11 students. One of those students has since transferred to the Mathematics Department; the remaining students have each selected a permanent research advisor and passed their Oral Exam/Thesis Proposal. The next cohort of 12 students joined the BE program in September 2000. This was also an outstanding group of high-achieving students, as evidenced by the number who received prestigious external fellowships, with seven receiving fellowships from the Whitaker Foundation, Hertz Foundation, National Science Foundation, and the Graduate Degrees for Minorities in Engineering/Science (GEM) program. This past spring's most recent graduate recruitment results were even more rewarding, as we admitted less than 10 percent of the applicants and over 75 percent have accepted our offers. We thus look forward to continued growth in this program as we welcome 15 new students in September 2001, plus two others who deferred enrollment until later in 2001–2002; of these, again, more than half have received external competitive fellowship awards. Of the 2000–2001 pool of 213 applicants to BEH, 11 were members of under-represented minority groups: African American (4), Mexican American (3), Puerto Rican (2), and Hispanic (2). Two minority students were offered admission; one accepted the offer to join our Ph.D. program, and has been selected for the prestigious Leventhal Fellowship by the Provost's Office.

The existing Toxicology Graduate Program was placed under the auspices of BEH in July 1998 with minimal disruption. Forty-three students were enrolled in 2000–2001; ten graduated during the year (8 Ph.D.; 2 S.M.). Four Toxicology students received external competitive fellowships, and three students received competitive MIT Fellowships awarded by the Graduate Dean's Office: the Leventhal Fellowship, Provost's Women/Minority Fellowship, and the Ida Green Fellowship. Of the fifteen applicants admitted to the Toxicology Ph.D. program for September 2001, nine accepted our offer.

The spring of 2001 saw a revision of the Toxicology graduate curriculum. The revision was undertaken as part of a long-range plan to broaden the program to reflect the evolving research activities of the toxicology faculty. The new name for the program, "Molecular and Systems Toxicology" reflects our goal of integrating technology and engineering with toxicology in the post-genomic era. Building on a foundation of molecular, biochemical, and analytical toxicology, the Molecular and Systems Toxicology graduate program stresses a systems approach to complex biological problems with the application of new tools and technologies to understand problems of human health and disease and to develop new therapeutics. In parallel with the Bioengineering graduate program, the

Molecular and Systems Toxicology curriculum now consists of four core subjects and two electives. The four new core subjects are BEH.201, BEH.214, BEH.215, and BEH.400J.

BEH.201 Systems Pharmacology and Toxicology addresses the chemical and biological analysis of the metabolism and distribution of drugs, toxins and chemicals in animals and humans, and the mechanism by which they cause therapeutic and toxic responses.

BEH.214 Human Pathophysiology addresses the mechanisms underlying selected human diseases, with particular emphasis on molecular and biochemical basis of pathogenesis.

BEH.215 Analytical Toxicology and Epidemiology deals with the logic and technology needed to discover essential causes and accelerating factors for human disease. In addition to the development of quantitative models of major mortal diseases, the subject addresses the evaluation of present day epidemiological and statistical methods for assessing roles of environmental factors.

BEH.400J Perspectives in Biological Engineering is an in-depth presentation and discussion of how engineering and biological approaches can be combined to solve problems in science and technology, emphasizing integration of biological information and methodologies with engineering analysis, synthesis, and design. The subject emphasizes the molecular mechanisms underlying cellular processes, including signal transduction, gene expression networks, and functional responses.

FACULTY NOTES

Honors and Awards

Professor John M. Essigmann received the Award for Research Excellence in the Field of Mutation Research. Given by the American Chemical Society, December 2000.

Professor Roger Kamm received the Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching.

Professor Robert S. Langer received a number of awards in 2000, including the Glaxo Wellcome International Achievement Award (Royal Pharmaceutical Society of Great Britain), Millennial Pharmaceutical Scientist Award (Millennial World Congress of Pharmaceutical Sciences), First Pierre Galletti Award (American Institute of Medicine and Biological Engineering), the Wallace Carothers Award (American Chemical Society) and an Honorary Doctorate from the Catholic University of Louvain, Belgium. Dr. Langer has also been honored as the Herman Beerman Lecturer (Society for Investigative Dermatology), the Millennial Lecturer (University of Liverpool), the Bayer Lecturer (University of Pittsburgh), the Bayer-Stein Honorary Lecturer (University of Massachusetts at Amherst), the William G. Lowrie Lectureship (The Ohio State University), the Frank T. Gucker Lecturer (Indiana University) and the First Patten Distinguished Lectureship (University of Colorado at Boulder).

Professor Douglas A. Lauffenburger was elected to National Academy of Engineering and Elected to American Academy of Arts and Sciences.

Professor Leona Samson received the American Cancer Society Research Professorship began in January 2001; The "Environmental Mutagen Society Annual Award for Research Excellence" was awarded in February 2001; and Keynote lecturer at the 2001 Gordon Research Conference on Genetic Toxicology in August 2001.

Professor James L. Sherley received the Samuel A. Goldblith Career Development Professorship (2000–2003) and was Charles E. Reed Faculty Initiatives Fund Recipient (2001).

Professor Gerald N. Wogan was appointed Princess Takamatsu Cancer Research Fund Lecturer for 2001 and received the Merit Award that accompanies the Lectureship.

Invited Lectures, Committees and Research

Professor Peter C. Dedon was appointed to the *Ad hoc* subcommittee of the MIT Environmental Health and Safety Committee; Chair of the MIT Radiation Protection Committee; and Program Chair of the Division of Chemical Toxicology of the American Chemical Society. He was also invited to give seminars at the Department of Pharmacology, University of Rochester, November 2000; Department of Chemistry, Tennessee State University, November 2000; Nitric Oxide Gordon Conference, February 2001; Division of Biological Chemistry, American Chemical Society, August 2001; 7th International Workshop on Radiation-induced DNA Damage, Nouan-le-Fuzelier, France, September 2001; Department of Medicinal Chemistry, University of Minnesota, October 2001; Department of Chemistry, Saint Olaf College, October 2001, Department of Chemistry, University of Maryland, Baltimore City, October 2001; and the Department of Radiology, University of Sherbrooke, October 2001.

Professor Bevin P. Engelward has made tremendous progress in developing the first mouse model in which genetic changes can be detected *in situ* within intact tissues of a mammal. This novel technology will make it possible to determine how different cell types within a tissue vary in their susceptibility to genetic change. The technology being used is exemplary of the BEH mission: namely, to combine expertise in biological sciences (molecular

biology/biochemistry/genetics) with expertise in engineering (mechanico-optical engineering). We were originally awarded a small amount of funding to provide the means for piloting this work. Because of our rapid progress, the NCI has whole heartedly endorsed phase II funding for this exciting research project.

Professor Linda Griffith continues to serve as Principal Investigator (PI) on a Defense Advanced Research Projects Agency (DARPA) project to develop tissue-based sensors for biological warfare agents, collaborating with R. Kamm, D. Schauer, J. Sherley, and S. Tannenbaum at MIT; J. Vacanti and R. Lee at Harvard Medical School; and J. Wands at Brown University. This project has been further expanded into a DuPont-MIT Alliance (DMA)-supported effort to develop physiological models for effects of environmental agents. A broad patent on the technology has been granted and MIT is in licensing discussions. Work also continues in the area of new polymers for tissue engineering and cell biology. She chaired the National Institutes of Health (NIH)/National Science Foundation (NSF) workshop on training and education in Bioengineering, Medical Engineering and BioInformatics and gave a plenary lecture at the NIH Bioengineering Consortium (BECON) conference on Reparative Medicine. Professor Griffith Presented several invited talks at conferences, other universities, and government panels. At MIT, she continues to serve as the Associate Director of Education for the Biotechnology Process Engineering Center (BPEC), the faculty advisor for the Biomedical Engineering Society, and as head of the Biotech Student Leadership Council.

Professor Douglas A. Lauffenburger initiated a new DARPA "Bio-Info-Micro" project with colleagues in BEH and elsewhere in the Institute.

Professor Leona D. Samson is the Project Leader for one of five projects of a huge Program Project Grant (PPG) that was recently approved for funding by the NCI. She will be part of an 18 member team from 12 different institutions across the US who succeeded in being awarded this roughly 15 million dollar Program Project Grant entitled "Structural Cell Biology of DNA Repair Machines." The center of gravity for this huge collaborative study will be at the Lawrence Berkeley National Laboratory (LBNL) at the University of California at Berkeley and the Co-PIs are John Tainer and Priscilla Cooper. Among other things, we will have a dedicated newly designed beam line for structural analyses of DNA repair complexes.

Associate Professor Ram Sasisekharan is involved in both the undergraduate as well as graduate education here at MIT to shape the new generation of bioengineers. He serves on a dozen MIT committees, and serves as the graduate officer for the Division of Bioengineering. He has been or is a consultant for over a dozen pharmaceutical/ biotechnology companies. He serves on the advisory board of two public companies, one of them being the largest pharmaceutical company in India. He has been an avid supporter of the MIT Industrial Liaison Program (ILP), and has visited and lectured many ILP companies. He is on a NIH study section representing the area of extracellular matrix, and was also invited to join the editorial board of Angiogenesis which is a forefront journal in the field. He has successfully raised research grants here at MIT—being a PI on three major NIH R01 research grants and a co-PI on an additional grant. He has received funding from industry to carry out research at MIT in the polysaccharide area. He was invited to set-up a structural-bioinformatics core here at MIT by the leaders in the glycobiology field, for a major NIH sponsored consortium.

Professor James L. Sherley participated in the following talks: August 14, 2000, "The Function Of The P53 Tumor Suppressor Gene In Healthy Cells," Department of Biochemistry, Meharry Medical College, Nashville, TN; November 13, 2000, "Molecular Determinants of Asymmetric Stem Cell Kinetics," Department of Embryology, Carnegie Institution of Washington, Baltimore, MD; November 20, 2000, "Molecular Determinants of Asymmetric Stem Cell Kinetics," Morphology and Motility Group, Department of Biology, Massachusetts Institute of Technology, Cambridge, MA; March 31, 2001, "Revival and Application of Principles of Asymmetric Stem Cell Kinetics," Haitian Scientific Society Seminar, Northeastern University, Boston, MA. Meeting Talks: August 23, 2000, "IMPDH: A Regulator Of Somatic Stem Cell Kinetics," Special Symposium: Inosine Monophosphate Dehydrogenase (IMPDH): Perspectives on a Major Therapeutic Target, 220th National Meeting of the American Chemical Society, Washington, D.C. (Talk described in: Witczak, Z. J. (2000) IDrugs 3, 1283–1284); July 19, 2001, "Molecular Determinants of Asymmetric Cell Kinetics," Workshop on Stem Cells, 60th Annual Meeting of the Society for Developmental Biology, University of Washington, Seattle. Patent Applications (2001–3 provisional applications filed): Sherley, J. L. , "Methods for *Ex Vivo* Propagation of Somatic Stem Cells"; Sherley, J. L. and Merok, J. R., "Unique Biological Properties of Stem Cells"; Semino, C., Shuguang, S. and Sherley, J. L., "Cellular Reprogramming in Peptide Scaffold and Uses Thereof."

Professor Ioannis V. Yannas's book *Tissue and Organ Regeneration in Adults* was published by Springer in July 2001. It is the first single-author book in the emerging field of tissue engineering. It is also the first book to describe the phenomenon of induced regeneration of organs.

More information about the Division of Bioengineering and Environmental Health can be found online at http://web.mit.edu/beh/.

Douglas A. Lauffenburger, Steven R. Tannenbaum

ENGINEERING SYSTEMS DIVISION

The academic year 2000–2001 was a year of accomplishment for the Engineering Systems Division (ESD) as we continued to move forward toward our goals to define and evolve engineering systems as a new field of study and to transform engineering education and practice.

The faculty of ESD continues to expand. There were two searches conducted this year for new junior faculty. ESD is delighted to announce that Olivier deWeck, Ph.D. was recruited as an Assistant Professor with a dual appointment in the Department of Aeronautics and Astronautics and Engineering Systems Division. Professor deWeck's research interests are in integrated multi-physics modeling and model-reality correlation strategies, as well as applications of modularity in the design, manufacture and deployment of space systems.

Currently, there are 31 faculty appointed: 24 in engineering and seven in management. As a division, ESD establishes an intellectual home for key programs and centers, engages faculty across departments and disciplines, and fosters discourse about engineering innovation.

In February, Ann Tremelling joined ESD as the Assistant Director for Administration. Prior to joining ESD, Ms. Tremelling was the Director of Academic Administration at Harvard Medical School.

The division coordinates academic programs with some 350 graduate students. The Leaders for Manufacturing, System Design and Management, Transportation, and Technology and Policy programs award master's degrees. Ph.D.s are offered in Transportation and in Technology, Management, and Policy.

ESD has four affiliated research centers: the Center for Technology, Policy, and Industrial Development; the Center for Transportation Studies; the Industrial Performance Center; and the Center for Innovation in Product Development. These are described elsewhere in the Reports to the President.

NEW INITIATIVES

Engineering Systems Learning Center

A new Engineering Systems Learning Center was established and serves as a repository and enabler for cases, simulators, and other educational material on complex systems. Joel Cutcher-Gershenfeld has been appointed as the Executive Director of the Engineering Systems Learning Center. With funding from the Sloan Foundation, senior faculty in the School of Engineering and the Sloan School of Management are crafting 10 individual cases that are the first of a series of studies, focusing on a wide range of topics including the auto, pharmaceutical and airline industries. The resulting product will eventually become accessible on-line to a wide audience and used for instruction at MIT, other universities and in industry.

Engineering Systems Knowledge Network

A number of ESD faculty and staff are involved in activities of the Cambridge-MIT Institute (CMI). In particular, the CMI Professional Practice Program (PPP), directed by Daniel Roos on the MIT side, has a number of initiatives with strong links to ESD. The CMI PPP represents a portfolio of educational offerings targeted at graduate students and practitioners, many of which are modeled after existing MIT programs such as the Technology and Policy Program (TPP). With a collaboration that began in the summer of 2000, TPP is the most advanced of the PPP efforts. Other ESD faculty are involved in joint curriculum development with Cambridge University colleagues to create case studies and other educational materials, and in the development of modules, executive education, lifelong learning courses, and other degree programs including a program modeled on MIT's Master of Engineering in Environmental Engineering. These activities complement the mission of the ESD Learning Center, and there are many synergies beginning to be explored. The Learning Center is well situated to serve as a central repository and sharing mechanism for a wealth of case studies and curriculum materials developed by CMI funded efforts in addition to the existing ESD efforts.

Essentials of Engineering

Professors Tom Eagar and Paul Lagace planned and implemented a new engineering systems subject aimed at freshmen looking to major in a department of the School of Engineering. Entitled "Essentials of Engineering," the subject introduces the range of skills necessary to become an outstanding engineer. Specifically, it is expected that the student will learn to recognize the various qualities a good engineer must posses and which of these are being taught (and not taught) explicitly in their future education and will use their later specific technical learning within the broader context of engineering practice as taught in this subject.

New Undergraduate Systems Minor

Professors Joseph Sussman and Deborah Nightingale are developing this minor which will be introduced in September 2002. The minor will broaden the engineering discipline-specific education in individual department majors to include systems thinking, design and analysis. The minor will address the multiple aspects of engineering systems, including products, processes, information, technology, organizational, and social-political dimensions.

Engineering Systems Symposium Committee

Engineering Systems Symposium Committee, led by Institute Professor Joel Moses is planning a major conference to discuss the intellectual foundations of engineering systems. The Committee has been developing background discussion papers in preparation for the conference.

FACULTY NOTES

Professor Daniel Hastings, Director of the Technology and Policy Program and Professor of Aeronautics and Astronautics and Engineering Systems, was appointed Associate Director of Engineering Systems Division. Professor Hastings will oversee all of the educational initiatives within ESD. Professor Hastings succeeds Professor Paul Lagace.

Professor David Marks was selected as the inaugural holder of the Morton (1942) and Claire Goulder and Family Professorship in Environmental Systems.

Professor Fred Moavenzadeh was awarded the James Mason Crafts Professorship of Engineering Systems.

Professor Joseph Sussman is working on the Mexico City project, focusing on developing top-down scenarios to identify policy options that can ameriorate the profound environmental problems of that huge city, without compromising mobility and economic growth objectives. This material is to be reflected in a new subject he is developing jointly with the Department of Urban Studies and Planning to consider large Latin America Cities.

Professor Thomas Allen received an honorary Ph.D. degree in Technology from Linköping University, Sweden.

Professor Paul Lagace received the Wayne Stinchcomb Award—American Society for Testing and Materials (ASTM) World Fellow of International Committee on Composite Materials (ICCM).

Professor Earll Murman and colleagues were awarded the 2000 Design and Development Prize for written papers published by the Royal Aeronautical Society. Murman, E.M., Walton, M., and Rebentisch, E. "Challenges in the Better, Faster, Cheaper Era of Aeronautical Design, Engineering and Manufacturing," *The Aeronautical Journal*, Oct 2000, pp 481–489.

Professor Cynthia Barnhardt received an award for "Best Research Paper" for her paper on "Composite Variables for Service Network Design," with Armacost, A., and Ware, K., Airline Group of the International Federation of Operational Research Societies (AGIFORS) Cargo Study Working Group 2000, Louisville, KY, June 2000.

Professor David Simchi-Levi's new book *Designing and Managing the Supply Chain* (with P. Kaminsky and E. Simchi-Levi, Irwin/McGraw-Hill, IL, 1999) won the Book-of-the-Year Award, and Outstanding IIE Publication Award, given in 2000 by the Institute of Industrial Engineers. The book provides state-of-the-art models, concepts and solution methods important in the design, control, operation and management of supply chain systems.

MAJOR MEETINGS

Visiting Committee

In February 2001, the Engineering Systems Division Visiting Committee spent two days meeting with members of the ESD administration and Division's leadership, and with senior and junior faculty, and students to conduct the initial review of this recently created Division. The Committee prepared a final report that was presented to the Corporation and to the members of the Engineering Systems Division. In its summation of their evaluation of the Division, the Committee stated:

> The creation of an Engineering Systems Division represents a very important undertaking for MIT. The endeavor is off to a very strong start in terms of collecting an excellent faculty, attracting a considerable number of able students, and acquiring financial and physical needed resources.

White House Office of Science and Technology Policy—25th Anniversary Symposium
The Office of Science and Technology Policy (OSTP) Symposium served to inaugurate a series of annual conferences oriented around major themes at the interface of technology and policy, as well as to consider the challenges facing practitioners of technology policy today. The symposium drew a number of highly distinguished individuals, including almost all the past heads of the Office, academics and professionals in the field, both as speakers and participants, who have played prominent roles in the arena of science and technology policy.

More information on the Engineering Systems Division can be found online at http://mit.edu/esd/www/.

Daniel Roos

ARTIFICIAL INTELLIGENCE LABORATORY

The MIT Artificial Intelligence Laboratory (AI Lab) has as its principal intellectual goal the understanding of human intelligence. As a practical matter the AI Lab develops the mathematics and engineering of intelligent systems and artifacts.

The MIT AI Lab has been in continuous existence since 1959, and currently has 22 faculty and senior and principal research scientists. The majority of faculty come form the department of Electrical Engineering and Computer Science, along with some from Brain and Cognitive Science and Aeronautical and Astronautical Engineering.

Financial support is provided by the Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), Nippon Telegraph and Telephone (NTT), Ford Motor Corporation, Yamaha Motor Corporation, the EPOCH Foundation (Taiwan), Flex Foot Incorporated, Alphatech Incorporated, Nokia, Philips, Hewlett Packard, Acer, Delta Electronics, Mitsubishi Research Laboratories, and Microsoft.

During the last year, the AI Lab completed its third year of partnership with NTT. The Laboratory for Computer Science also participates in this partnership, although it is administered at MIT through the AI Lab. Complementarily the MIT Oxygen Project is administered through the Laboratory for Computer Science, and the AI Lab participates in it through subcontracts. This last year has marked the completion of the first full year of industrial collaboration under Project Oxygen. The companies involved are Nokia, Philips, Hewlett Packard, Acer, Delta Electronics, and NTT.

The AI Lab also set up to host the campus portion of the Martinos Center for Structural and Functional Biomedical Imaging.

RESEARCH

The research activities of the laboratory are divided into ten general areas: foundations of artificial intelligence and learning; applied artificial intelligence and learning; biologically inspired robots and models; computational support for people; medical robots; medical vision; mobile robotics; new models of computation; vision and sound applied to people and activity; and vision techniques. Two page research abstracts of 116 individual projects at the lab can be found at http://www.ai.mit.edu/research/abstracts/abstracts2000/index.html. Some of the highlights of the year are as follows.

Vision and Sound Applied to People and Activity

Professor Trevor Darrell and his students have developed new methods for tracking people as they move about open spaces, and for estimating their head pose. This work is forming the basis for new modes of interaction between people and computers as part of project Oxygen.

Professor Eric Grimson and his students have developed new techniques for extracting anatomical structures from various imaging sources. These form the basis for new diagnostic tools.

Medical Robots

Professor Gill Pratt, Dr. Hugh Herr, and their students completed a new version of a prosthetic knee, and put it into clinical trials. The new knee can sense whether the wearer is walking up or down stairs, or at different speeds on flat ground, and adapt its behavior to make walking smoother and easier. The knee is now going into commercial production.

New Models of Computation

Dr. Thomas Knight and his students have successfully implemented computation inside living E. coli cells. They compile computations to DNA strings and insert these into the genome of E. coli. When the RNA transcription mechanism encounters these strings it implements the desired computation. Cells performing different computations communicated with each other via lactone molecules.

Computational Support for People

Mr. Krzysztof Gajos, the AI Lab Oxygen coordinator, has lead a group of students in developing a deployable software system to form the core of the Project Oxygen Enviro 21 systems. Metaglue is a distributed, always available, migratory, checkpointing, agent-based backbone on top of which the projects below have been built. Mr. Jack Costanza has managed an effort to install the necessary hardware, the Metaglue system, and an intelligent office application in a number of faculty and student offices throughout the AI Lab. This is part of our effort to live within the Oxygen system for pervasive human centered computation that we are building.

Professor Randall Davis and his students have built a system which can understand sketches of mechanical systems and incorporate spoken annotations by the user. The system feeds the models into physical simulators. Since the user is sketching on virtual whiteboard the effect is that the "paper" they are using is intelligent and understands what the user is sketching. Professor Davis and his students are working to extend this idea to the domain of software development.

Dr. Howard Shrobe and his students have created a collaboration tool that provides support for meetings in intelligent offices. The system keeps track of decisions that are made in meetings, files them for later use, and provides relevant video clips from the meeting as an annotation for these decisions. In this way it automatically captures the rationale for decisions for later use.

Biologically Inspired Robots and Models
Dr. Cynthia Breazeal, Dr. Brian Scassellati, and other students of Professor Rodney Brooks, extended the ideas of sociable robots. Along with Dr. Una-May O'Reilly they delivered a new version of the robot Kismet to NTT. They developed new theories of social interaction and built models of language acquisition, animate and inanimate discrimination, gaze direction detection, and simple shared attention. All these systems were implemented on the robots Kismet and Cog.

More information on the Artificial Intelligence Laboratory can be found online at http://www.ai.mit.edu/.

Rodney A. Brooks

BIOTECHNOLOGY PROCESS ENGINEERING CENTER

The Biotechnology Process Engineering Center (BPEC) as a National Science Foundation Engineering Research Center (NSF ERC), is a multi-disciplinary body with faculty members from the MIT Departments of Biology, Chemistry, and Chemical Engineering, the Division of Bioengineering and Environmental Health (BEH), and the Whitehead Institute for Biomedical Research, along with the University of Toronto Department of Chemical Engineering and the Brown University School of Medicine Liver Center. The mission of BPEC is to carry out research and education combining engineering with molecular biology, emphasizing a strong relationship with industry in its various activities. The goals of the Center are to perform cutting-edge, fundamental research in therapeutic gene and protein biotechnology based on contributions from, and interactions among, investigators from diverse relevant backgrounds.

HIGHLIGHTS

The NSF celebrated the 15th Anniversary of the ERC program at their fall 2000 Annual Meeting. Since BPEC is the ERC class of 1985, it took an active role in this celebration. The BPEC remains committed to its core mission of fostering interdisciplinary research and education fusing engineering with molecular cell biology, with emphasis on strategic problem-solving and close interactions with the biotechnology industry. BPEC's NSF-supported Strategic Plan continues to focus on therapeutic gene biotechnology, with two major engineered-system objectives: an *ex vivo* approach employing genetically-engineered stem cells (BPEC Project Area A), and an *in vivo* approach employing targeted viral or synthetic vectors (BPEC Project Area B). This plan leverages and synergizes with our broader MIT mandate to catalyze research and education at the biology/engineering interface, prominently including the academic unit charged with creating and operating curricular degree programs in this area, the Division of Bioengineering and Environmental Health (BEH).

Educational programs of BPEC deal with the needs of undergraduates, graduates and industrial personnel. The goals of the educational programs are to provide integrated and broad bioengineering perspectives to the students. We have reenergized our Student Leadership Council with new members and activities. At the undergraduate level we now participate in the Biomedical Engineering Minor offered by BEH to students in all majors, while at the graduate level we likewise participate in the Bioengineering and Toxicology Ph.D. programs offered by BEH along with the traditional Ph.D. programs in Biology, Chemistry, and Chemical Engineering. We added a new degree program in BEH, the Masters of Engineering in Biomedical Engineering, which offers an opportunity for students to carry out thesis research in industry. In addition, National Institute of Health (NIH) Training Programs in Biotechnology and in Genomics are administered from the BPEC office, leveraging the NSF ERC to broader educational opportunities at the engineering/molecular-biology interface. Undergraduate research is achieved through the Undergraduate Research Opportunities Program (UROP) for MIT students and the Research Experience for Undergraduates (REU) for non-MIT students. Special one-week summer courses are offered to industrial personnel

Industrial activities and planning are coordinated through our Therapeutic Gene Biotechnology Industrial Consortium Advisory Board (TGB ICAB), supervised by our BPEC team of Industrial Liaison Officer (Matt Croughan) and Associate Industrial Liaison Officer (Jean-Francois Hamel). We are extremely pleased by the progress we have made this past year in our BPEC/industry partnerships. We more than doubled the size of our Industrial Consortium Advisory Board (ICAB), from seven to 16 members, and have received the most strongly positive ICAB SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis since the BPEC reconfiguration three years ago.

The DuPont-MIT Alliance (DMA) (a BPEC administrative umbrella) in Bio-Based Materials, is another facet of the BPEC mission to combine engineering with molecular biology. This Alliance provides $7M per year to MIT for a five-year period, and nicely extends the impact of the BPEC engineering/biology collaborative spirit to even broader reaches of the MIT campus and industry. The DMA funded 17 projects with 16 primary Principal Investigators (PIs) and 14 graduate fellowships during fiscal year 2001. Several faculty gave lectures at DuPont and two industrial short courses are in the planning stage for fiscal year 2002.

Statistically reporting, 141 personnel took part in the center's NSF strategic plan research activities during fiscal year 2001. This figure comprises of the following: 45 MIT Undergraduate worked as lab interns (i.e., UROP students), 12 non MIT undergraduates who participated in the center's NSF Research Education for Undergraduates Program (REU); 24 graduate students; 26 postdoctoral associates/fellows; 12 visiting scientists, engineers, industry

researchers, eight administrative personnel, two other director level personnel and 12 faculty (some faculty served as executive directors).

MILESTONES AND GOALS

Research — Therapeutic Gene Biotechnology

The overall objective of Project Area A, aimed toward the engineered system of genetically-engineered hematopoietic stem cells [HSCs], is to develop the knowledge-base and technology-base for generating and expanding HSCs in culture, transfecting them stably with particular therapeutic genes, selecting the HSCs with appropriate transgene integration and expression, and delivering them to a host. The three major Projects, being undertaken collaboratively among a number of the BPEC investigators (Daley, Griffith, Jaenisch, Lauffenburger, Lodish, Zandstra), are directed toward corresponding bottlenecks: A1—Control of HSC Proliferation; A2—Generation of HSCs from embryonic stem (ES) cells; A3—Transfection of ES cells.

The overall objective of Project Area B, aimed toward the engineered system of targeted gene delivery vectors for liver cancer, is to develop the knowledge-base and technology-base for specific ligand-targeted viral (mainly adenoviral) and non-viral (mainly synthetic polymer and peptide) vehicles carrying therapeutic genes, and delivering them to a host. The three major Projects, being undertaken collaboratively among a number of the BPEC investigators (Griffith, Langer, Lauffenburger, Sherley, Wands, Wittrup, Zhang), are directed toward corresponding bottlenecks: B1—Quantitative Assays of and Studies on Barriers to Gene Delivery; B2—Ligand-Based Targeting; B3—Synthetic Vehicles.

In total, then, comparing our progress and current status with the BPEC Strategic Plan Timeline, approaches, and methodologies have arisen. These new enhancements include:

- Proteomic and genomic approaches to understanding of new regulatory components for HSC proliferation;
- Tissue-engineered bone marrow bioreactors for HSC production;
- Studies of synergistic signaling by extracellular matrix and cytokines for differentiation of ES cells into HSCs;
- Mathematical model for intracellular processes involved in vector uptake, trafficking and expression;
- Application of synthetic polymer vehicles for gene delivery to the brain for neurodegenerative diseases; and
- Toxicogenomic approaches to adverse liver cell effects due to gene delivery vector uptake.

These are combining with our "on track" original plan to further accelerate our progress in our Strategic Plan toward creating engineered systems of: stem cell gene delivery therapies; and synthetic and targeted gene delivery therapies.

Education

Our objectives remain to impact the education of undergraduate students, graduate students, and industrial personnel in their ability to work at the engineering/biology interface on important problems in biotechnology.

Undergraduate Education

At the undergraduate level, our goal is to ensure the students are integrated into our research thrusts for both MIT (UROP) students and students from other institutions (REU and high schools). To expose the students to cross-disciplinary activities and teamwork, the projects are selected carefully and critically. BPEC provides initial experiences to undergraduates and encourages students to work in industry as internees. Our Industrial Liaison Officers and Education Coordinators contact companies associated with BPEC for summer undergraduate internships and the replies are then matched with BPEC's undergraduates for summer employment.

The Division of Bioengineering and Environmental Health (BEH) has now further enhanced its undergraduate curriculum aimed at integrating molecular cell biology with engineering, by developing a new five-year S.B./M.Eng. program in Biomedical Engineering (BME) to accompany the ongoing Biomedical Engineering S.B. Minor program. The BME Minor is MIT's first inter-departmental minor degree, available to undergraduates taking any S.B. Major degree at the Institute. The program comprises four subjects in Biomedical Engineering—two core subjects and two electives. These subjects require substantial preparation in science and engineering, and thus the minor is structured in the form of a Science Core (three subjects) and an Engineering Core (two subjects) which serve as prerequisites for the Biomedical Engineering subjects. The goal of the degree program is to educate students in how to apply fundamental engineering principles to solve challenging problems in biology and medicine. A common theme is the integration of individual components of a biological system to describe both the spatial and temporal organization of the system as a whole. The scale of this integration may be as small as molecules and cells or as large as organ

systems or whole organisms. Students gain an appreciation of how to solve problems at these different scales by taking two core Biomedical Engineering courses. They can then pursue particular interests through the two restricted electives in Biomedical Engineering.

More than ever, cutting-edge research combining engineering with molecular biology concomitantly requires analogously novel educational programs, and BPEC is at the heart of the Division of Bioengineering and Environmental Health (BEH). BEH is a departmental structure within the School of Engineering charged with creating and administering educational and research programs that forge engineering with modern biology. Rather than focusing on a particular application field like most "biomedical engineering" departments being created across the country, BEH is focused on fostering a new discipline of biological engineering that will educate engineers to create technologies based on molecular biology whether the application area is medicine, environment, agriculture, materials, manufacturing, or so forth. BEH has initiated a new Bioengineering Ph.D. program with a novel core curriculum aimed at training this type of next-generation biotechnologist, alongside students trained in inter-disciplinary fashion in the MIT Departments of Chemical Engineering, Chemistry, and Biology—with all these programs intertwined through the NIH Training Programs in Biotechnology and Genomics also administered by BPEC.

During this past year, however, we have taken yet another major step forward in our undergraduate educational efforts by establishing a new five-year combined S.B./M.Eng. degree program in Biomedical Engineering. With this program, an MIT undergraduate can obtain his or her S.B. degree in any Major along with a M.Eng. degree in Biomedical Engineering within an integrated five-year period. The curriculum splices key aspects of the BME Minor with some of our Bioengineering (BE) Ph.D. core subjects, and adds an independent research project leading to a M.Eng. thesis.

One especially exciting opportunity that the M.Eng. leads to is the possibility of students carrying out their thesis research in an industrial setting, such as in a laboratory at one of our Industry Advisory Consortium Board (ICAB) partner companies. We are beginning to pursue discussions with some of our ICAB members about ways to move along this very attractive avenue.

Graduate Education

At the graduate level, one of the goals of BPEC is to provide research experience related to the center's research thrusts. We ensure that the research is conducted with a spirit of teamwork and inter-disciplinary input. This is achieved by joint faculty advisors on the doctoral thesis and/or thesis committee members from different departments and disciplines. To provide industrial perspectives on the students' training program, industrial personnel are often members of doctoral thesis committees. In addition, our industrial collaborators have also participated in course lectures, both for undergraduates and graduates. To further integrate our graduate students into the industrial environment, our students are part of our technology transfer activities to industry. In this capacity, the students obtain valuable perspectives on industrial research and development and, at the same time, act as the conduit to testbeds at industrial sites. Our graduate students also actively participate as teaching assistants (TAs) in the courses which are related to the center's research thrusts. This training provides experience in teaching in case the students are planning careers in academia.

Through the efforts of the BPEC, the Interdepartmental Biotechnology Training Program successfully completed its 12th year. Twenty-four Training Faculty participate from the Departments of Biology, Chemistry, Chemical Engineering, and Mathematics, and the Division of Bioengineering and Environmental Health. This training grant is funded by NIH National Institute of General Medical Sciences (NIGMS) with a total of 20 pre-doctoral trainees and recently received a new award for an additional five years.

The mission of BEH is to educate leaders, and generate and communicate new knowledge, at the interface between engineering and biology. The central premise of BEH is that the science of biology will be as important to technology and society in the next century as physics and chemistry have been in the one now ending. Therefore, engineers and scientists must be educated people who: can apply their measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions, or subjected to pathogens or toxins; and can apply their design perspective to creating innovative biology-based technologies in medical diagnostic, therapeutic, and device industries, or in non-health-related industrial sectors such as agriculture, environment, materials, or manufacturing. That is, we must educate a

new generation of people who can solve problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems. Hence, a key function of BEH is to create and support curricula in which biology and engineering are taught as synergistically as possible, and the new BE PhD program is aimed directly toward accomplishing this function. The new program is designed to bring together engineering and biology in as fundamental a manner as possible. Stated broadly, it will educate students to use engineering principles in the analysis and manipulation of biological systems, to solve problems across a spectrum of important applications. Accordingly, the curriculum will emphasize fundamental concepts more than particular applications. By learning to advance both engineering and biological knowledge, it is anticipated that the graduates will be well positioned to contribute to many areas of research in both academic and industrial settings.

In its initial year of its operation, 1999–2000, 11 outstanding first year bioengineering graduate students were brought in; our goal for the foreseeable future is to recruit ~10–15 new graduate students per year. The typical entering students hold a B.S .(or M.S.) degree in an engineering discipline (typically Biomedical, Chemical, Electrical, Mechanical, Materials Science, or Computer Science). During their first year, the students pursue a unified core curriculum, in which approaches from the various engineering disciplines will be used to examine biological materials and organisms over a wide range of length and time scales. The core curriculum, which will consist largely of subjects not offered previously at MIT, will be the hallmark of the new program. The program will have its own Ph.D. qualifying exams, the written part of which will be based on the core curriculum. To enhance depth and breadth, the core subjects will be supplemented by electives in the biological sciences and engineering. A student's research will ordinarily begin near the end of the first year, leading after approximately five years of total residence to a completed Ph.D. thesis.

Leadership in The Field and Involvement with Others

There are many indicators noting how BPEC is recognized and respected as a national center to the professional communities. One measure on the outreach and leadership of the ERC faculty is the invited presentations to the various biotechnology communities. The 12 faculty members in the BPEC during fiscal 2001 participated in the following categories:

Seminars at Universities	=45
Seminars at Industry	=22
Presentation at National and International Conference and Symposium	=28
Workshop/Short Course Parcipitation	=2

A significant number of the BPEC faculty have been recognized by invited distinguished lectureships across the country, major awards and prizes, and fellow election in professional societies. It is our opinion the data presented above demonstrates the Center's outreach and leadership in the field of biotechnology.

An indicator of outreach from BPEC is its collaborative efforts with other universities in education and/or research.

BPEC has entered into a partnership with the bioengineering-related ERCs at Georgia Tech and University of Washington to co-sponsor an annual Workshop; in March 2001; it was held at Hilton Head, SC. This partnership is fostering positive interactions among these three bioengineering-related ERCs, and indeed MIT and Georgia Tech are developing plans to identify new collaborative research projects under joint ERC auspices. An example of this collaboration is the anticipation to carry out a partnership in Education and research. With GTEC as the lead center, a supplemental NSF Partnerships in Education and Research proposal has been awarded for summer 2002.

FUTURE GOALS FOR FISCAL YEAR 2002

BPEC's objectives remain to impact the education of undergraduate students, graduate students, and industrial personnel in their ability to work at the engineering/biology interface on important problems in biotechnology. In order to carry out these objectives, BPEC plans to continue its outreach involvement in undergraduate and graduate education through the BEH, NIH Training Grants, UROP and NSF REU programs, and industrial internships. At the K–12 level, BPEC has started collaborations with the Science Coordinator for the Cambridge School Department and has received funding from NSF for a Research Experience for Teacher s award in collaboration with Johns Hopkins University. In addition, through collaborative and team efforts continue its research focus in gene therapeutics.

Planned personnel changes for fiscal year 2002 include the participation of Professor Leona Samson, a new toxogenomics BEH faculty member.

PERSONNEL CHANGES

We have added a new investigator, Professor James Sherley of BEH, who is an expert in tissue cell kinetics (and, moreover, is a member of an under-represented minority group). We have recently hired a new Information Systems Administrator to oversee all of BPEC's computer systems.

More information about this the Biotechnology Process Engineering Center can be found at http://web.mit.edu/bpec/.

Audrey Jones Childs

CENTER FOR INNOVATION IN PRODUCT DEVELOPMENT

The Center for Innovation in Product Development (CIPD) links representatives from academia, industry, and government who share our dynamic vision of the future of product development: new products will be developed by just-in-time collaborations of globally-distributed teams linked seamlessly by web-based tools and processes. These collaborations will be formed by means of a services marketplace, where lead firms will find the world's best suppliers of information, components, and support services.

Our mission is to lay the conceptual groundwork for, and contribute core components to, a product development infrastructure that will help companies to thrive in the new services marketplace. Using industrial sites as our laboratories, we work with engineers and managers in product development environments to extend our fundamental understanding of the product development process, and provide innovative improvements to current practice.

Established in 1996 as one of the National Science Foundation's (NSF) Engineering Research Centers, CIPD is interdepartmental research program joining MIT's School of Engineering with the Sloan School of Management. Our 16 faculty and 18 graduate students pursue research that has been funded by the NSF and 10 industrial partners, with a budget in FY 2001–2002 of $2.2 million.

Since its inception, CIPD has executed over 173 research projects, and produced over 110 refereed journal articles, 81 conference papers, and 21 awards for outstanding research. Under the guidance of Co-Directors Professor Maurice Holmes and Professor Steven Eppinger, and Assistant Director Nils Nordal, CIPD continues to advance the theory and practice of product development with integrated programs of research, education, and outreach.

RESEARCH PROGRAMS

CIPD's seven interrelated research initiatives are:

- Virtual Customer (VC): Professor John Hauser, lead
- Distributed Object Modeling Environment (DOME): Professor David Wallace, lead
- Incentives and Boundaries (IB): Professor Rebecca Henderson, lead
- Implementation Dynamics (ID): Professor Nelson Repenning, lead
- Information Flow Modeling (IFM): Dr. Daniel Whitney, lead
- Platform Architectures (PA): Dr. Kevin Otto, lead
- Product Development Integration Lab (PDIL): Professor Maurice Holmes, lead

Virtual Customer

Successful product development (PD) demands good customer input. However, PD teams often are unable to get good customer input because of cumbersome, slow, expensive, or outdated collection methods. The Virtual Customer initiative seeks to improve customer input through a portfolio of web-based methods that allow PD teams to seamlessly incorporate customer preferences into their PD process. Because PD teams are increasingly distributed around the world, the virtual customer "engine" emphasizes web-based methods that facilitate globally-dispersed teams.

This past year, we made significant progress on our six virtual customer methods—web-based conjoint analysis, fast polyhedral adaptive conjoint analysis, user design, virtual concept testing, securities trading of concepts, and the information pump. These methods have been applied by our researchers at Xerox, Ford, and Polaroid (at Polaroid, they contributed to the successful redesign of the I-Zone camera).

Demonstrations and working papers are available at the Virtual Customer web site (mitsloan.mit.edu/vc). This site is a major practical output of the project, and includes demos of various virtual customer methods. It will also begin to post, over the next year, open-source code that will allow researchers and practitioners to download software applicable to market research.

Lastly, we have developed tools for User Design and for web-based conjoint analysis. These tools have been used in course 15.828 Design and Marketing of New Products, by student teams to quickly create virtual customer web sites. These tools will be refined and posted in open-source format on the VC web site.

Distributed Object Modeling Environment

This CIPD centerpiece is our largest initiative, and commercial interest in it has grown steadily over the past year. DOME offers a fundamentally new infrastructure for integrated modeling and simulation. Overcoming the extreme difficulties of large product simulations, DOME provides a "World-Wide Modeling Web" that allows all developers to participate equally in simulation—even when they are separated by great distances, and are using different

modeling tools and computing environments. DOME also secures proprietary knowledge, ensuring that each member of the design process has only the appropriate and necessary information.

Accomplishments for the DOME project this past year include: a patent (in progress) for a novel assembly process using DOME; journal publications in the American Society of Mechanical Engineers (ASME) *Journal of Mechanical Design* and the *Journal of Industrial Ecology;* and major new pilot studies initiated at Ford and Boeing. In addition, two commercial startup ventures (Oculus and Zionex) developed an independent interpretation of the published DOME concept, and are producing a commercially available product. Finally, the industry-driven DOME working group that began in the fall of 1999 has continued to meet regularly and successfully.

Our primary plan for the next year is to design and research the implementation of a next-generation DOME concept that will provide the foundation for a world-wide simulation web.

Incentives and Boundaries

The explosion of information and information technologies has led many firms to evolve a dispersed product development process with people and organizations spread around the world. Incentives within an organization must therefore communicate the company's fundamental intentions not only to people within the organization, but to those beyond it. In the services marketplace that we envision, incentives must cross the boundaries of the organization and reach the virtual enterprises.

To coordinate such dispersed processes, managers must foster a culture that implicitly rewards and motivates product development teams to perform against a set of common strategic metrics. Those metrics may include customer satisfaction, time to market, defect reduction, and platform reuse. We focus on a practical method to fine-tune a firm's relative emphasis on these metrics. In particular, we seek to advise a firm how to modify their emphasis on each metric in order to improve profits and/or efficiency.

Journal articles detailing the results of the IB initiative are forthcoming in *Organization Science*, and have been submitted to *Management Science*. Over the next year, we will add greater emphasis on evaluation and industrial testing of our methods. We will also build a model for the US Navy that provides insight into how to best modify incentives for reduced lifetime costs of shipboard systems. Finally, we will integrate this initiative's results with other CIPD research. For example, the DOME project is now using the IB initiative's "3-T" model to frame boundary issues that exist in implementing DOME.

Implementation Dynamics

We are developing a methodology for estimating a given product development system's capacity. Complementing many of the advances in the theory of process design, this methodology will advance the theory of process improvement and implementation. Such a theory should explain high rates of failure, and should provide the basis for developing an implementation methodology that will prevent future failures.

During this past year, five of our research papers on PD implementation have been published (or accepted for publication) in distinguished academic journals. We have also presented our work widely at both academic and practitioner conferences.

Having recently completed a four-month study of a DOME implementation effort on-site at Ford Motor Company, we will write up our results in a paper that will be complete in the next year. Lastly, we are completing a three-year study of how development processes are used at Xerox, and will finish writing up our conclusions by the end of 2001.

Information Flow Modeling

We are developing advanced methods for the management of knowledge used in the engineering design process. These methods are based on the techniques of information flow modeling through the application of design structure matrices (DSMs). The resulting visual representations of development activities serve as maps for understanding and improving the PD process.

IFM research serves to help engineers and managers to achieve greater value in the development cycle of complex products. Over the coming year we will complete the development of decision support tools that will allow product developers to reduce risks in the PD process and optimize product performance (with specific application to jet engine design). This work has special significance to the DOME initiative, which began collaboration in the fall of 2000. Thesis work in this area will begin in the spring of 2002.

IFM research on spiral development aims to determine which conditions warrant the use of spiral product development processes rather than stage-gate processes. We laid the groundwork for our investigation in the past year by rigorously defining the spiral and stage-gate processes. In June 2001, we began applying mathematical models to spiral processes at Verizon, and will complete that work in September. Also in June we completed a case study on spiral applications in the computer hardware industry (ITT Industries). In July we will have completed case studies of Ford and Pratt & Whitney, and in August at IDE and Xerox. By the project's end in April 2002, we will have determined the selection criteria necessary to make an effective choice between spiral and stage-gate product development processes.

IFM research on system level knowledge strives to increase understanding about the capture and management of design information in complex products. Using DSM, we map out the exchange of knowledge during a project's early development. Our aim is to better convert top-level specifications into component specifications, and to insure that components in complex systems work harmoniously.

Collaborations between Ford, Pratt & Whitney, Otis Elevator, and Veeco-CVC have proven the value of our novel uses of DSM. In the summer of 2001 we will conduct a case study at Johnson and Johnson, and will conclude analysis in the fall. Deliverables will include a paper presented the ASME 13th International Conference on Design Theory and Methodology in September.

Platform Architectures

This initiative has focused on defining a theory of platform architecture, with an emphasis on the definition of successful product families. This theory would :

- Match customer needs with function;
- Match function with technology;
- Transform technology into a set of integrated design modules; and
- Screen and optimize these modules against a set of portfolio architecture principles.

We completed this research on May 31, 2001, and results have been disseminated throughout the Xerox Corporation, especially in the System Design and Integration (SDI) group. Our methodologies have been implemented as case studies that help engineers to more effectively define products and product architectures.

Product Development Integration Lab

CIPD established the Product Development Integration Laboratory (PDIL)for several reasons:

- Foster intellectual ties with engineers and scientists from industry;
- Facilitate a two-way flow of ideas leading to participation in the Center's research and education programs; and
- Assist in the transfer of knowledge and technological advances to industry.

Equipped with $150,000 of state-of-the-art displays and video conferencing equipment, the PDIL can demonstrate the feasibility of web-based product development systems that integrate research from CIPD with commercial enterprises and other universities. In addition, the lab makes new technologies available for undergraduate, graduate, and professional education.

This past year, the PDIL supported efforts toward the development and application of a systems engineering submarine design methodology. In partnership with MIT's Ocean Engineering Department, this project investigated the worldwide web as a vehicle for including many collaborators in the submarine design process. We provided computer, network, and some CIPD student desk space; collaboration also included employees from Xerox.

Our current on-site work includes the deployment of DSM tools and methodologies at General Motors; a thesis drawn from this effort will be finished in the spring of 2002. We are also exploring the feasibility of deploying Virtual Customer for the Gould Pump Division of ITT Industries.

Finally, the Lab supported various projects in other departments at MIT: the Space Systems, Policy, and Analysis Research Consortium (SSPARC) program in Aeronautics and Astronautics, the Sharing FIRST (For Inspiration and Recognition of Science and Technology) program, and the Ocean Engineering Department all used our conference, computer, and video conference facilities.

OTHER RESEARCH HIGHLIGHTS

Parlin Award

Professor John Hauser, Kirin Professor of Marketing at the Sloan School of Management, and CIPD Virtual Customer research initiative leader, has been chosen as the next Charles Coolidge Parlin Award winner for distinguished achievement in marketing research. The yearly award was established in 1945 by the Philadelphia

chapter of the American Marketing Association and the Wharton School in association with Curtis Publishing Company to honor Charles Coolidge Parlin, "the father of marketing research." The Parlin Award is the oldest and most distinguished award in the marketing research field, recognizing outstanding leadership and sustained influence on the evolving profession of marketing research.

Research at Xerox Palo Alto Research Center PARC

Research co-sponsored by CIPD at the Xerox Palo Alto Research Center (PARC) this year investigated knowledge sharing among product development teams. Two papers resulted, and were accepted for publication in the *Journal of Engineering Education* and the *Proceedings of International Conference on Engineering Design* (August 2001). Related research on the sharing of PD process knowledge among non-competitive firms resulted in various conference papers, and in one paper accepted for publication in the *Journal of Knowledge and Process Management.*

Plans for the coming year include an empirical analysis of process implementation based on case studies of three very different product teams: one using a radically new technology; one targeting a relatively new market; and one using the firm's traditional technology and targeting the firm's traditional markets.

EDUCATIONAL PROGRAMS

CIPD is an interdisciplinary program between the School of Engineering and the School of Management. We believe that students' course experiences should address the interplay between the technical, social, and system elements of product development, and prepare them for work in the globally distributed services marketplace.

As an NSF Engineering Research Center, our educational mission has been to promote product development as part of core engineering curriculums both at MIT and throughout the United States. As noted in last year's Report to the President, the National Science Foundation elected not to extend funding to CIPD beyond January 2002, and we thus began the process of transitioning into a more independent research center. After carefully evaluating our strategy and programs, we decided to maximize our efforts in research to create more value for our industry sponsors. Our research has made us a vital ally to our current industry membership, and all nine of our current partners (Ford, General Motors, IBM, IDE, ITT Industries, Polaroid, Product Genesis, US Navy, Xerox Corporation) remain fully committed to CIPD. To better serve them, we have concluded ancillary education programs that, valuable in themselves, draw resources away from our primary research focus. In particular, we have concluded our obligations to the outreach programs FAIHM and MITE^{2}S (Minority Introduction to Engineering, Entrepreneurship, and Science). Our substantially reduced commitment to those programs frees resources for the research that will serve MIT and our industry sponsors in the years to come.

Our current PD educational programs target three communities: working professionals, graduate students, and undergraduates.

For Working Professionals

The System Design and Management (SDM) Product Development Track was created in collaboration with MIT's SDM program. This two-year degree program targets mid-career engineering professionals who are potential leaders in product development. Students in the program continue to work for their employers at least half-time while pursuing their degree through an innovative educational structure: courses are broadcast to the students' company sites. Several times per year, students visit MIT to participate in special PD course modules, and for one semester in their program, students study on campus. At course completion, students receive an MIT S.M. degree in Engineering and Management.

To date, 13 faculty have participated in the SDM track, and 195 students from 54 organizations have enrolled. In January 2001, those organizations included Arvin Meritor, BAE Systems, the Chilean Army, Ford, Kodak, Lucent, National Aeronautics and Space Administration (NASA), Nortel, Northeast Utilities, US Air Force, and UTC.

SDM plans to keep its cohort at approximately 50 students per year using the current format. However, we anticipate growth through collaboration with industry partners who are interested in extending SDM education through other formats. For example, United Technologies Corporation has approached SDM with an interest in a systems integration curriculum that could impact 3,000 employees over the next three years. If successful, work on this project could be leveraged to include other Leaders for Manufacturing-System Design Management (LFM-SDM) industry partners.

Product Development for the 21st Century

CIPD began disseminating the SDM product development curriculum in 1998. Collaborating with the University of Detroit Mercy (UDM) and the Rochester Institute of Technology (RIT), we helped to create and implement the program called Product Development for the 21st Century (PD21), the Education Consortium for Product

Development Leadership in the 21st Century. Guided by our industrial sponsors Xerox and Ford, the schools copy MIT's core PD curriculum, but emphasize project and case study work relevant in their geographic areas (optics in Rochester and automobiles in Detroit). The first PD21 students graduated from their respective schools in December 2000.

The Naval Postgraduate School (NPS) at Monterey joined the PD21 consortium in May 2000, and the first students entered its program in September. CIPD Co-Director Maurice Holmes participated in the program launch by presenting a concentrated course on-site at NPS. Introducing case studies on PD leadership, Professor Holmes taught 21 mid-career fast track Naval officers for one week in September. In addition, a cohort of 15 NPS students and 2 faculty visited MIT in June 2001, linking NPS students with their SDM and CIPD counterparts.

PD21 workshops brought together numerous students, faculty, and industry leaders this past year. In July 2000, CIPD hosted the two-day workshop, "Capturing the Value of the PD21 Program," which focused on gaining the most worth from the PD21 program, both from the point of view of students and their industry sponsors. In June 2001, NPS at Monterey hosted the three-day workshop, "System Engineering," which emphasized the integration of project management and system engineering.

PD21 consortium members met in June 2000 to review progress thus far and consider plans for the future. Members agreed unanimously that that the first phase of PD21—that of establishing the consortium as a multi-institutional platform for PD education—was a clear success. Over 400 students to date have enrolled in the program at the four schools, and 145 have graduated. The consortium established a committee to draft a statement of vision and objectives for PD21's second phase—disseminating the program beyond the core membership. This plan will be complete by the end of 2001.

With the PD21 program now firmly established, CIPD is free to reevaluate our commitment to PD21, given our transition away from a role as an NSF Engineering Research Center, and our increased allocation of resources on research that will more directly benefit MIT and our industry sponsors.

Executive Education Courses

CIPD faculty created and are teaching a full suite of short courses as non-degree offerings. These industrial mini-courses (15 this year) are offered throughout the year through MIT's office of summer professional programs and through Sloan's office of special executive programs. In addition, SDM faculty offer 12 courses by distance learning through the SDM Product Development Track.

For Graduate Students

Center Co-Director Steve Eppinger teaches a semester-long class, 15.783J (or 2.739J, or ESD.32J), entitled Product Design and Development. The class focuses on integration of the marketing, design, and manufacturing functions of the firm in creating a new product. Student teams develop new product concepts and create prototypes. This past semester, the class was composed of 90 graduate students from the School of Engineering, the Sloan School of Management, and the Rhode Island School of Design. Professor Eppinger was joined by other CIPD faculty who helped to teach this class: Professor Maurice Holmes, Dr. Dan Whitney, and Professor Thomas Roemer.

An associated web site (with its construction supported by CIPD) provides an extensive set of resources for students and support materials for faculty teaching comparable courses at other institutions. The site is organized around the book *Product Design and Development* as taught at MIT, and can be found at http://www/ulrich-eppinger.net/.

CIPD collaborated on the design of a semester-long MBA course based on an integrated theory of the firm. The course, 15.903 Integrative Course in Organizational Theory incorporates the latest (often CIPD-funded) research while analyzing insights from organizational theory and economics. The course was taught for the first time in the fall of 2000.

In June 2001, MIT awarded 10 Master's degrees and one Ph.D. degree to students funded by CIPD. An additional two Master's students and four Ph.D. students are expected to graduate later in 2001.

For Undergraduate Students

CIPD supported Professor Earll Murman in the development of a freshman seminar Introduction to Product Development. The seminar introduces freshman to product development with a project they undertake alongside PD professionals. (The course is co-taught by an MIT faculty member and a PD leader from industry.) CIPD sponsored Professor Murman is participating in the creation of a seminar instructor's guide. Available in May 2001, the guide is designed to enable institutions outside MIT to offer this course.

CIPD funded three UROP students for a project at the Center for Sports Innovation. They concentrated on applying the product development process to the sport of baseball. In particular, students investigated the design of a system for automatic detection of balls and strikes thrown during a game.

The class 2.007 Design and Manufacturing I teaches undergraduates the process of design by having them build machines that, in a grand finale at the end of the term, compete in a class-wide contest. This year, thanks to grants from Ford and GM, the students had no lab fee, and they could keep their machines when the class concluded. Led by Alex Slocum, teaching staff included CIPD faculty David Wallace and Woodie Flowers, and CIPD industry affiliates Sandy Campbell (Xerox) and Chris Magee (Ford).

Through a past grant from the National Science Foundation, CIPD provided equipment for lab facilities used by undergraduates. As part of their PD classes and student-defined activities in several engineering departments, undergraduates could develop and test prototypes to better understand how products are made. The final complement of new equipment was installed by the end of summer 2000, in new laboratory space that MIT elected to construct in the Aeronautics and Astronautics complex. The facility became available in the fall of 2000, and has been used by hundreds of undergraduates working on PD projects.

OUTREACH PROGRAMS

The center's outreach activities aim to provide life-long learning experiences for business professionals. A collaboration of researchers and industry participants who are actively engaged in Distributed Object Modeling Environment Working Group (DOME) projects, the DOME Working Group is open to individuals and organizations that are actively involved in planning or executing a DOME project or pilot. The DOME Working Group meets regularly, with each member organization taking turns hosting a meeting. In February 2001, the Ford Motor Company served as host.

In September 2000, CIPD co-sponsored the Second International Design Structure Matrix Workshop on DSM along with the Lean Aero-space Initiative, Leaders for Manufacturing, and Ford Motor Company. Over 25 speakers presented research at this highly interactive gathering, which was attended by over 75 participants from industry, government, and academia (a 50 percent increase in attendance from the previous year). The Third International DSM Workshop will be held in October 2001.

SPONSORSHIP

While funded by the NSF, our industrial partnerships were limited to companies within the United States. CIPD is now actively seeking new partnerships, and in 2000–2001 we hosted visits by nearly 30 companies from around the world. They included such well-known firms as 3M, Boeing, Dessault, GE Corporate Research, Harley-Davidson, Nokia, Newell-Rubbermaid, Oracle, Saab, and Volvo.

Our goal for the coming years is to recruit partners in industry sectors that complement our existing membership. Our current partners operate mainly in the industrial, capital goods, technology hardware and equipment sectors, and we will target the telecommunications, aerospace, software, and information technology sectors.

Our partner companies have indicated a desire for a new sponsorship arrangement, one that better integrates our research and educational offerings. In July 2001, CIPD Co-Director Steven Eppinger assumed additional responsibility as Sloan Co-Director of LFM-SDM. With closer ties to these two programs, we are exploring an arrangement whereby LFM-SDM partner companies would sponsor CIPD doctoral students in conjunction with their LFM-SDM Master's degree internships.

OTHER RECENT EVENTS

The following is a list of recent events for the academic year 2000–2001:

- July 2000: Sloan Executive Education—Managing Complex Product Development Projects
- August 2000: Industry/NAVY R&D Partnership Conference—This conference promoted dialogue between government, industry, and academia. The first of its kind, this conference focused on reducing barriers to integrating commercial products with R&D in Naval systems.
- September 2000: Second International Design Structure Matrix Workshop—Researchers presented the latest DSM theory and techniques, while practitioners had a chance to report on successful (or unsuccessful) experiences with DSM, including critical success factors and barriers to successful DSM methodology implementation. In addition, software developers demonstrated current DSM software implementation.
- October 2000: CIPD Executive Council Meeting—This meeting reviewed the summer's activities, and planned CIPD research for the following year; and CIPD Fall Research Review—This first of two annual reviews presented the latest theoretical and applied research conducted at CIPD. Intended for senior executives and managers involved in PD activities, it combined presentations about research projects with networking sessions

for industry partners, CIPD faculty, and students. The review focused on three of CIPD's core initiatives: Information Flow Modeling (IFM), Implementation Dynamics (ID), and Distributed Object Modeling Environment (DOME).

- December 2000: CIPD Industry Workshop; Sloan Executive Education—Managing Complex Product Development Projects; and Sloan Executive Education—Developing and Managing a Successful Technology and Product Strategy.
- February 2001: CIPD Governing Board Meeting; DOME Working Group Meeting—Hosted by Ford Motor Company; and CIPD Spring Research Review—This review complemented the Fall Research Review by focusing on CIPD's remaining core initiatives: Virtual Customer (VC), Incentives and Boundaries (IB), Platform Architectures (PA), and the Product Development Integration Lab (PDIL).
- March 2001: Sloan Executive Education—Developing and Managing a Successful Technology and Product Strategy; and Sloan Executive Education—Managing Complex Product Development Projects.
- May 2001: Sloan Executive Program: Developing and Managing a Successful Technology and Product Strategy.
- June 2001: Sloan Executive Program: Product Design, Development, and Management.

PERSONNEL CHANGES

The center's leadership structure has changed only nominally in the past year, providing evidence of our greater assurance in a role as a predominantly research-based center. Professors Steven D. Eppinger and Maurice Holmes remain Co-Directors of CIPD. Nils Nordal was promoted to Assistant Director in January 2001.

In addition, Michael Mack was hired as Communications Coordinator, and Sharon Bradshaw was hired as Manager of Finance (Ms. Bradshaw is also a member of the Sloan School's Office of Finance and Administration). Finally, Kathleen Sullivan joined CIPD as Office Manager, Cara Barber joined as Assistant to Professor Eppinger, and Sarah Davitt joined as Assistant to Professor Holmes.

More information about the Center for Innovation in Product Development can be found online at http://web.mit.edu/cipd/.

Nils Nordal

CENTER FOR TECHNOLOGY, POLICY, AND INDUSTRIAL DEVELOPMENT

MIT faculty and researchers at the Center for Technology, Policy, and Industrial Development (CTPID) work collaboratively with over 65 sponsoring corporations and government agencies to develop new knowledge and technological strategies that support global economic growth and advance policies that preserve the environment and benefit society at large.

CTPID's nine interdisciplinary research programs focus on contemporary industrial problems—such as how to build safe, affordable, and environmentally friendly automobiles—that span social, natural, and technological interests. Established in 1985, CTPID's programs, which generated nearly $8.8 million in research funding in FY2001, address industrial issues in the aerospace, automotive, materials systems, mobility, telecommunications, and technology and law sectors.

Over 50 faculty and researchers at MIT's Schools of Engineering; Management; and Humanities, Arts, and Social Sciences are affiliated with the center and a hundred more scholars at MIT and other prestigious universities participate in research projects. Faculty and CTPID researchers lead these programs: the Cooperative Mobility Program (CMP); Ford-MIT Alliance (administered by CTPID); International Motor Vehicle Program (IMVP); Labor Aerospace Research Agenda (LARA); Lean Aerospace Initiative (LAI); Lean Sustainment Initiative (LSI); Materials Systems Laboratory (MSL); Research Program on Communications Policy (RPCP); and Technology and Law Program (T&L).

HIGHLIGHTS

Nearly 100 industry, government, and academic representatives attended CTPID's November 8–9, 2000, conference, "The Third Wave: Industry Opportunities for the Internet-Enabled Future," described as "A Multidisciplinary and Cross-Industry Exploration of How Information Technologies and the Internet Are Challenging—And Changing—the Aerospace, Transportation, Communications, and Resources Industries." Keynotes focused on the impact of the Internet on the automotive industry, trust-based marketing on the Internet, and the future of the Internet itself. A panel on 21st century government-industry-academe partnerships presented talks by Engineering Systems Division (ESD) Associate Dean Daniel Roos; Dr. Christopher Magee, Executive Director of the Ford-MIT Alliance; and Dr. William Berry, Associate Deputy Assistant Secretary of US Air Force. Afternoon panels featured recent research by CTPID programs and discussion of the impact of information technologies on each research sector. The conference was co-sponsored by MIT's Office of Corporate Relations and generated a number of new contacts between programs and potential sponsors.

The International Motor Vehicle Program launched a new research phase titled Navigating Auto's Next Economy, focusing on these research areas: Managing the Extended Enterprise, E-Automotive, and Visions for a Sustainable Future. Researchers and sponsors met in MIT and in London to review new research and set program priorities. John Paul MacDuffie, Associate Professor in Management, Wharton School, University of Pennsylvania, is Co-Director and Fred Moavenzadeh is acting Co-Director. Donna Carty, a former IMVP administrator, is program manager. MacDuffie spoke on global supply networks at the April conference, "Sloan Foundation Industry Centers Executive Briefing: Corporate Strategies for the Digital Economy."

Lean Aerospace Initiative Co-Director Earll Murman, Professor of Aeronautics and Astronautics, won a Royal Aeronautical Society Written Paper Prize 2000 for an article co-authored with Myles Walton and Eric Rebentisch, "Challenges in the better, faster, cheaper era of aeronautical design, engineering, and manufacturing" published in the October 2000 issue of *The Aeronautical Journal.* A book titled *Lean Enterprise Value: Insight's from MIT's Lean Aerospace Initiative* and co-authored by a team of LAI researchers was written and submitted to Palgrave, a new global academic publisher at St. Martin's Press. Publication is scheduled for the spring of 2002.

Key speakers at LAI's "Growing the Lean Community" conference in April included Mike Sears, Senior Vice President and CFO of the Boeing Company, and MGen Michael Mushala, Air Force Program Executive Officer for Fighter and Bomber Programs, SAF/AQ (Secretary of the Air Force/Acquisition). More than 250 industry, government, and academic leaders gathered to focus on the growth of lean initiatives throughout the aerospace enterprise.

A rap star was among RPCP's four new Internet and Telecoms Convergence Consortium members to speak at a January meeting hosted by British Telecom in Astral Park, UK. Rap star Chuck D of Rapstation.com, the dinner speaker, discussed artists' rights and the Internet. Vanu Bose of Vanu Inc. spoke on Software Radio; Dave Hays, Pelago Networks, discussed Enhanced Local Services; and Steve Lanning, Aerie Networks, addressed Bandwidth Demand Elasticity and its Implications for Infrastructure Provisioning.

Ford-MIT Alliance Executive Director Chris Magee has been appointed a Professor of the Practice in Mechanical Engineering and is teaching classes in that department. In other Ford news, MIT's three Nobel Prize-winning economists—Professors Emeriti Paul A. Samuelson, Franco Modigliani and Robert M. Solow—made a rare public appearance together when they delivered the inaugural Ford-MIT Nobel Laureate Lecture, September 18, in Kresge Auditorium.

The Cooperative Mobility Program served as the basis for a large-scale global study of passenger and freight mobility this year. CMP was a core contributor to a report on Mobility 2001 that was prepared for the World Business Council on Sustainable Mobility.

Labor Aerospace Research Agenda completed its second year, secured funding through 2002, and produced five case studies including *From Three to One: Integrating a High Performance Work Organization Process, Lean Production and Activity Based Costing Change Invitations* on the Boeing Corporation.

New sponsors and member companies: RPCP/Internet and Telecoms Convergence Consortium (ITC) new sponsors include Fundacion Retevision, Marconi, Dantis, Ellacoya Networks, Rapstation.com, Vanu Inc. and Zephyr Telecommunications. LAI welcomed two new consortium members this fall: Curtiss-Wright Flight Systems, which manufactures hydraulic actuators and hydraulic motors, and Spectrum Astro, which develops space systems for defense, scientific, and commercial use. Two new sponsors will support the Lean Sustainment Initiative next year: Boeing and Chromalloy.

CTPID researchers from three programs presented their work at the MIT Series on Technology and the Corporation conference "Technology and Design: MIT's Vision for the Automobile," May 16–17 in Kresge Auditorium. Daniel Roos, Associate Dean of Engineering Systems and Cooperative Mobility Program Director, spoke on "The Auto in the 21st Century: Challenges and Opportunities." Charles H. Fine, IMVP researcher, addressed "Automotive Supply Chains in the Internet Age." CTPID Senior Research Engineer Frank Field, III, talked about "Recycling Strategies in Automotive Industries."

Communications Office activities included the development and promotion of the Third Wave conference and ongoing efforts in several areas.

The CTPID web site focused on center and program news and continued to build a repository of information through publications and links to CTPID research and activities. A book-length Technology and Law study titled "Public Participation in Contaminated Communities" is now online at http://web.mit.edu/ctpid/www/tl/TL-pub-PPCC.html.

CTPID published three issues of the newsletter *IMPACT: Emerging Work from CTPID.* Two 12-page issues included interviews with industry leaders, program news, researcher profiles, and new publications. A special 28-page winter issue presented the proceedings of the Third Wave conference.

CTPID Community Lunches fostering intellectual conversation among diverse programs featured four programs: Ford, Mobility, LAI, and LSI.

The center and Industrial Liaison Program (ILP) co-sponsored, promoted, and publicized two MIT Industry Leaders in Technology and Management Lectures featuring Texas Instruments Chairman Tom Engibolus, February 8, and Michael C. Ruettgers, CEO of EMC Corporation, May 2.

CTPID was accepted as an early adopter of the MIT Library's DSpace project, an innovative project that will house MIT's intellectual products in a web-based database.

CTPID continues to play a key role in the Engineering Systems Division's development by helping to define ESD's research agenda and contributing to its development. Both CTPID's research programs and 26-year-old graduate program are now part of ESD. The Master's Technology and Policy Program and the Doctoral Technology, Management, and Policy Program enrolled 143 students in 2000–2001; 48 students earned S.M. degrees and seven earned Ph.D.s.

The inaugural Technology and Policy Program annual conference celebrated the 25th anniversary of the White House Office of Science and Technology Policy on May 1 in the Wong Auditorium. Presidential Science Advisers from Truman advisory William Golden to Neal F. Lane, Clinton's science and technology advisor, spoke on the critical issues they faced in science and technology policy.

ESD is moving to co-locate its research and education programs in E40 with plans to site research centers and ESD headquarters near CTPID on the second floor and education programs on the third floor. The establishment of the Laboratory for Energy and the Environment (LFEE) in E40 has created an opportunity for CTPID's Materials Systems Lab to move to the fourth floor, thus bringing more CTPID programs in closer proximity.

COOPERATIVE MOBILITY PROGRAM

The Cooperative Mobility Program brings together transportation scholars from MIT and other universities with private sector specialists and corporate sponsors to explore current and future issues of worldwide mobility. CMP proposes a new vision: a sustainable multimodal transportation system that will provide the mobility necessary to foster global economic development compatible with social needs and environmental concerns.

CMP is grounded in empirical research on travel behavior, technological approaches, and public policies that affect mobility in both developed and developing countries. It compiles an annual Mobility Observatory that tracks innovative developments in transportation policy, management, and technology.

This past year the program served as the basis for a large-scale global study of passenger and freight mobility. A report on Mobility 2001 was prepared for the World Business Council on Sustainable Mobility.
More information about the Cooperative Mobility Program can be found online at http://esd.mit.edu/ctpid/cmp/cmp-home.htm.

FORD-MIT ALLIANCE

In an innovative program, the Ford Motor Company has engaged the Institute in addressing an array of 21st century challenges confronting the automotive manufacturer. The multimillion-dollar, five-year alliance begun in 1997 focuses on three research areas: product development process technology, virtual education, and the environment. Priorities include the study of engineering design and educational environments of the future and funding to support a major MIT-directed consortium to study and address global environmental challenges. An objective of the alliance is the development of effective mechanisms for long-term, corporate-university partnerships.

CTPID administers the overall grant and is home to several of the Ford-MIT Alliance projects. As part of Ford's engineering research, CTPID Senior Research Scientist, Daniel Whitney is leading a project on Assembly Advisor, incorporating assembly information in computer-aided design systems. He is also involved, with Professor Steven Eppinger, in a project called Information-Based Product Development that explores appropriate information technology tools for synthesizing complex information in product development programs. Janice Klein, Senior Lecturer at the Sloan School of Management, heads research on Virtual Teams. George Roth, Executive Director of the Ford-MIT Alliance Program and Research Associate in the Sloan School of Management, also leads a research effort on the organizational changes implied by MIT's alliances with corporations.

As part of strengthening the linkage between MIT and Ford and developing new collaborative research areas, Chris Magee, Ford's Executive Director of the Alliance, is resident at MIT. In addition to his involvement in the projects and programs funded by Ford, Dr. Magee has been appointed a Professor of the Practice in Mechanical Engineering and is teaching classes in that department.

As a partner in this Institute-wide initiative, CTPID supports over a dozen projects and twenty researchers working on Ford-MIT projects. MIT faculty involved in the Ford-MIT Alliance use conferences, videoconferences, web sites, and virtual forums to communicate the results of this work to both Ford and the general public.

More information about the Ford-MIT Alliance can be found online at http://ford-mit.mit.edu/.

INTERNATIONAL MOTOR VEHICLE PROGRAM

IMVP, the largest international research group studying and reporting on the automobile industry and its global milieu, launched Phase IV, titled Navigating Auto's Next Economy (NextAuto), in September.

IMVP's Phase IV provides industry-wide knowledge and insight essential to helping companies make strategic decisions. Today the global auto industry is facing critical decisions about its future. Tightening profit margins, rising customer demands, and realignments along the value chain are challenging automakers and suppliers alike. Global operations and technological options from telematics to green drive trains call for new value propositions. Competitive dynamics and the ground rules for collaboration are in flux as automakers consolidate and form alliances and as new mega-suppliers emerge.

Since 1980, IMVP has provided an unbiased, detailed, and integrated view of the dynamics of the worldwide automotive industry and its important drivers. IMVP and its predecessor, the Future of the Automobile program, have received funding from the Sloan Foundation, automakers worldwide, and their suppliers since the late '70s.

Navigating Auto's Next Economy (NextAuto) reflects sponsor feedback urging IMVP to draw upon its historic strengths to examine the industry's next challenges. Through NextAuto, IMVP researchers and their industry partners will integrate research capabilities on the extended enterprise with the new opportunities afforded by e-business and catalyzed by environmental and sustainability issues. Three-year research priorities were set in a London meeting in March.

Over twenty projects are underway in 2000–2001 in the following research areas:
Managing The Extended Enterprise
- Benchmarking the Value Chain
- Modularity and Outsourcing
- R&D: Product Development Strategies
- Building Skills and Capabilities Across Boundaries

E-Automotive
- e-Supply Chains and Hubs
- e-Powered Consumers/Build-to-Order
- Telematics: Vehicle as IT/Telecom Platform

Visions For A Sustainable Future
- Green Drive Trains
- New Materials, Recycling, and Environmental Management

Mobility Solutions

Associate Professor John Paul MacDuffie at the Wharton School is IMVP Co-Director and Professor Fred Moavenzadeh is acting Co-Director. Donna Carty is program manager. More information about this program can be found online at http://web.mit.edu/ctpid/www/imvp/.

LABOR AEROSPACE RESEARCH AGENDA

The goals and objectives of LARA have not changed since last report. They are to facilitate the transfer of lean concepts into the defense aerospace industry. LARA will advance the knowledge of the leaders and members of the two principle unions that represent workers in the aerospace industry—the International Association of Machinists (IAM) and the United Auto Workers (UAW)—around the challenges and opportunities associated with lean principles and other aspects of new work systems. It also serves as a platform to educate government and industry leaders on these same issues.

Accomplishments

Second phase funding for project secured October 3, 2000–October 2002.

21st Century Aerospace Workplace presentation given at the LAI Plenary and LAI Executive in April and May 2001 respectively. Commitment made to support newly established Presidential commission on the future of the aerospace industry with data on 21st Century Aerospace Workforce issues.

The following case studies were completed:
- Boeing Corporation, From Three to One: Integrating a High Performance Work Organization Process, Lean Production and Activity Based Costing Change Invitations;
- Collective Bargaining in the Face of Instability, A Resource for Workers and Employers in the U.S. Aerospace Industry;
- International Association of Machinists, Boeing Joint Programs, A Decade of Learning;
- Pratt & Whitney (United Technologies), Fostering Workplace Innovation and Labor Management Partnership: The Challenge of Strategic Shifts in Business Operations;
- Rocketdyne Propulsion and Power, Transformation Through Employee Involvement and Workplace Training: The Challenge of Changing Business Context; and
- Textron Systems, Fostering Continuous Improvement in a Changing Business Context.

Additionally, analysis continues on data from individual surveys (nearly 500 respondents) and facility surveys (national random sample of 196 aerospace facilities), as well as progress on a global mapping of first-tier suppliers for a cross-section of commercial and military platforms.

Future Plans

A panel follow-up survey, a white paper for Presidential Commission, additional Case Studies, and dissemination of products and findings.

LEAN AEROSPACE INITIATIVE

The Lean Aerospace Initiative (LAI) is a consortium-guided MIT research program managed under the auspices of the Center for Technology, Policy, and Industrial Development in collaboration with the Department of Aeronautics and Astronautics. Research is conducted by over a dozen faculty members from the Schools of Engineering and Management, graduate students from several MIT courses and graduate programs, and staff members of CTPID. LAI is an active partnership among 23 aerospace companies, 13 U.S. government agencies, labor representatives, and MIT. It also collaborates internationally with LARP (Lean Aerospace Research Program) at Linköping University and the UK LAI.

The initiative was formally launched in 1993 out of practicality and necessity as declining defense procurement budgets collided with military industrial over-capacity prompting a demand for "cheaper, faster, and better" products using a philosophy called lean. Lean means adding value by eliminating waste, being responsive to change, focusing on quality, and enhancing the effectiveness of the workforce. It was documented in the U.S. by researchers from MIT's International Motor Vehicle Program and in the book, *The Machine That Changed The World.*

Since lean is much broader than production, integrative research addresses the entire and extended business enterprise. This research examines Manufacturing Systems; Supplier Networks; Product Development with Test and Space Operations; Acquisition; Organizations and People. Research rich products such as the Lean Enterprise Model (LEM) result, creating a foundation of reference tools for common awareness, language, and understanding of lean principles.

Research Results and Related Products

The key research findings are: subsystem commonality is a lean design strategy, one that reduces cost, variability, excess assets and infrastructure; (Data show 15–40 percent savings in acquisition cost of subsystem and 20–45 percent savings in annual operating and support costs,) proper management policies can enhance intellectual capital growth and prevent poor performance in one program from impacting other programs in the portfolio; and in an analysis of spacecraft operations, LAI researchers found that for most programs, 70–90 percent of problems are associated with the ground system thereby making spacecraft subsystems a very small percentage of root cause.

During the past year, LAI's Knowledge Deployment and Lean Enterprise product teams translated research results into educational, leadership, and transformational tools including:

- Lean Learning I Workshop, October 31, November 1–2, 2000, whereby 85 partners from the LAI community grappled with the fundamentals of adult learning and organizational change;
- LESAT (Lean Enterprise Self Assessment Tool), BETA version;
- Enterprise Transition to Lean Guide and Roadmap (TTL);
- Production Ops TTL; and
- 21 data sheets added to the Lean Enterprise Model (LEM).

As of May 2001, LAI has 46 graduated M.S. and Ph.D. students with:

- 7 entering government service
- 9 entering aerospace industry
- 14 entering consulting industry
- 14 entering other professions
- 2 continuing studies at MIT

Moving Forward

In summary, LAI has made significant progress on research rich products and has provided a solid knowledge base for implementation efforts. This is complemented by member outreach events, such as Plenary Conferences, to accelerate knowledge transfer. LAI has also actively grown its lean community with new consortium members and by engaging additional leadership in open dialogue and strategy through an Executive Roundtable.

Professor Earll Murman from the Department of Aeronautics and Astronautics and Professor Tom Allen from the Sloan School of Management are Co-Directors. Fred Stahl is the Stakeholder Co-Director for LAI.
More information about the Lean Aerospace Initiative program can be found at http://web.mit.edu/lean/.

LEAN SUSTAINMENT INITIATIVE

Lean Sustainment Initiative's (LSI) mission is to enable fundamental transformation of the U.S. commercial and military maintenance, repair, and overhaul (MRO) industries into a cost-effective, quality-driven, timely, and responsive support system.

Highlights

LSI developed a universal framework by which the MRO of generic corporate assets may be defined, analyzed, synthesized, and transformed. This universal framework applies to MRO activities in aviation, land-based transportation, seaport and docks, airports, real estate, hospitals, and many other large complex corporate enterprises.

LSI established three research teams to focus on sustainment operations, business processes, and enterprise level MRO activities at U.S. Air Force depots. The sustainment operations team addressed the problem of insufficient parts and materials in U.S. Air Force depots. The business processes team investigated the unsatisfactory performance of forecasting models and methods employed by the U.S. Air Force (USAF) to correctly define requirements. The enterprise level team continued its study of goals, objectives, and metrics that drive behavior and performance at the flight line; this study has produced "metrics thermostats" for MRO operations at the flight line.

LSI delivered presentations based on LSI research at major national conferences held on the campus of Arizona State University, Massachusetts Institute of Technology, and Princeton University.

LSI produced several master's theses, white papers, and technical briefings.

LSI expanded the stakeholder base to include two U.S. commercial aircraft MRO companies.

LSI was described by the Commander, USAF Materiel Command before the House Armed Services Committee, 23 March 2001, as an undertaking to identify critical breakthroughs and change the paradigm of maintenance, repair, and overhaul support for the 21st century.

Future Plans

Expand the stakeholder base to include national and international corporations and foundations; develop curricula based on LSI research findings and the LSI-derived universal framework for MRO activities research.

MATERIALS SYSTEMS LABORATORY

The Materials Systems Laboratory (MSL), directed by Richard Roth, is internationally recognized for its innovative work analyzing the competitive position of materials and the strategic implications of material choice. For nearly two decades, MSL has addressed the issues arising from materials choice in a range of applications, particularly those in the automotive, electronic, and aerospace industries, but with a recent emphasis on automotive applications. MSL's research sponsors include major automakers and materials suppliers. Recent agreements with General Motors should provide MSL will the basis for doing more in-depth research into various aspects of automotive manufacturing.

MSL's work builds upon a unique combination of materials processing knowledge, engineering design practice, manufacturing process analysis, and environmental information to construct analytical tools for decision support and competitive analysis. To develop these tools, MSL has worked extensively to refine its extensions to classic engineering process modeling for the past two decades. Modeling elements have been married to elements of product design, material properties, and manufacturing assumptions to yield tools that can estimate the costs of product manufacture under a wide range of conditions. These tools analyze primary materials production, primary materials processing, component and subassembly manufacture, and end-of-life vehicle processing. In each case, these tools estimate the costs of production as a function of processing technology, material flows, operating conditions, and energy and capital requirements.

MSL also has developed techniques for understanding how markets respond to the different combinations of engineering and economic performance available by using different materials. Further, MSL researchers analyze the environmental consequences of materials and process choice, incorporating the emerging life-cycle analysis paradigm. These tools make it possible, when used with economic and engineering assessments, to develop robust, credible,

More information about the Materials Systems Laboratory can be found online at http://web.mit.edu/ctpid/www/msl/.

RESEARCH PROGRAM ON COMMUNICATIONS POLICY

The Internet and Telecoms Convergence Consortium (ITC) is a sponsored research program at MIT consisting of industry and academic partners who collaborate on research into the technical, economic, strategic, and policy issues that arise from the convergence of telecommunications and the Internet. ITC is the principal research vehicle for the MIT Research Program on Communications Policy.

Highlights of the Year

Internet Appliances and Applications: David Clark and John Wroclawski of MIT received National Science Foundation (NSF) funding to continue their Laboratory for Computer Science (LCS) project to develop an advanced mobile communications device.

Local Access and the Broadband Transition: William Lehr of MIT and Lee McKnight of Tufts investigated quality of Internet service in their work on consumer service level agreements within a broadband access market framework. David Gabel of MIT and Queens College analyzed accessibility of broadband communication by various segments of the U.S. population. Ben Compaine of MIT addressed the issue of the disappearing digital divide in the United States. Broadband was a central focus of the June ITC Members meeting hosted by Motorola, Inc.

Global Internet Economics and Industry Structure: Attention to the technologies and policies evolving for expanded use of spectrum was also prominent at ITC members meetings. Flippo Illardi of Tufts, reporting on ITC-funded research, assessed the future of bandwidth trading markets, while Bill Lehr (MIT) reported early work on the evolving economic and policy issues involved in of secondary markets for spectrum. Shawn O'Donnell of MIT completed a first draft of a map of the cash flows of the Internet players.

The ITC web site was redesigned, updated and expanded. It includes periodically refreshed links to current news and information on its home page, as well as links to slides from most weekly research seminars, student papers and staff publications.

Internet and Telecoms Convergence Consortium Books, Papers, and Publications

Vogelsang, Ingo and Benjamin Compaine, editors. *The Internet Upheaval: Raising Questions, Seeking Answers in Communications Policy.* MIT Press, 2000.

McKnight, Lee W., Paul M. Vaaler and Raul L. Katz , editors. *Creative Destruction: Business Survival Strategies in the Global Internet Economy.* MIT Press, 2000.

McKnight, Lee W., William Lehr, and David D. Clark, editors. *Internet Telephony.* MIT Press, 2001.

O'Donnell, Shawn. "Broadband Architectures, ISP Business Plans, and Open Access." Presented at TPRC 2000, Alexandria, VA., September 23–25th, 2000.

Cukor, Peter and Lee McKnight. "Knowledge Networks, the Internet, and Development." Presented at TPRC 2000, Alexandria, VA., September 23–25th, 2000.

McGarty, Terrence. "The Evolution of International Internet Telephony." Presented by Russ Neuman at TPRC 2000, Alexandria, VA., September 23–25th, 2000.

Lehr, William and Lee McKnight. "A Broadband Access Market Framework: Towards Consumer Service Level Agreements." Presented at TPRC 2000, Alexandria, VA., September 23–25th, 2000.

Gillett, Sharon Eisner, William Lehr, John Wroclawski, and David Clark. "A Taxonomy of Internet Appliances." Presented at TPRC 2000, Alexandria, VA., September 23–25th, 2000.

Clark, David and Marjory Blumenthal "Rethinking the Design of the Internet: end to end arguments vs. the brave new world." Presented at TPRC 2000, Alexandria, VA., September 23–25th, 2000.
Compaine, Ben. "Re-Examining the Digital Divide." Paper presented at TPRC 2000, Alexandria, VA, Sept. 23–25th, 2000.

Gabel, David and Florence Kwan. "Accessibility of Broadband Communication Services by Various Segments of the American Population." Presented at TPRC 2000, Alexandria, VA, Sept. 23–25th, 2000.

Uzuner, Ozlem and Lee McKnight. "Sales Tax on the Internet: When and How to Tax?" Proceedings of Hawaiian International Conference on System Sciences, HICSS'34, January 2001, Maui.

Finances/Funding

ITC gained two new major members while losing one, for a total of seven large enterprise members: British Telecom, Fundacion Retevision, Hewlett Packard, Marconi, Motorola, Nokia, and Sprint. There are also five small company members: Dantis, Ellacoya Networks, Rapstation.com, Vanu Inc., and Zephyr Telecommunications. Motorola, Inc., as host of the June 2001 member's meeting, assumed many of the costs of that conference.

Future Plans

Forthcoming book: Benjamin Compaine and Shane Greenstein, *Communications Policy in Transition: The Internet and Beyond* (MIT Press, 2001).

Forthcoming papers: Benjamin Compaine and Emma Smith, "Internet Radio: A New Engine for Content Diversity?" (International Telecommunications Society, Dublin, Sept 2001); and Sharon Gillett, William Lehr, John Wroclawski and David Clark. "Do Appliances Threaten Internet Innovation?" IEEE Communications for special issue on Internet appliances, October 2001.

Planned conferences: Members Meeting, January 17–16, 2002, Cambridge, MA; June, 2002, Madrid, Spain.

Personnel Changes

Dr. Benjamin Compaine, an information policy and mass media specialist, began working with RPCP this year. Dr. Compaine has held academic appointments as well as executive corporate positions. Dr. David Gabel, an economist on leave from Queens College, is spending two years with ITC as a research affiliate. He studies Internet access issues. Dr. Jean Camp, Assistant Professor of Public Policy at Harvard's Kennedy School, will work with ITC on information policy issues, Internet commerce and Internet survivability, and the policy implications of technical decisions. Rita Adom became ITC's administrative assistant.

TECHNOLOGY AND LAW PROGRAM

The Technology and Law (T&L) Program offers research opportunities and graduate-level courses focusing on the interface of law and technology. Research activities include the design and evaluation of policies that encourage technological change for preventing chemical pollution through regulation, liability, and economic incentives, promote environmental justice by involving communities in governmental decisions that affect their health, safety, and environment; and address the effects of globalization on sustainability.

T&L offers a two-semester sequence in environmental law and policy: Law: Technology, and Public Policy, a core subject in the Technology and Policy Program; and Sustainability, Trade, and Environment, listed jointly with Engineering and Sloan.

Recent publications include:

Ashford, N. A. "Government And Innovation In Environmental Transformations In Europe And North America," in Special Issue on Ecological Modernization, Sonnenfeld, David and Mol, Arthur, (Eds.) *American Behavioral Scientist*, Vol. 45, 2002.

Ashford, N. A. and Caldart, C. C. "Negotiated Environmental and Occupational Health and Safety agreements in the United States: Lessons for Policy," *Journal of Cleaner Production*, 2001, Volume 9, Number 2, pp. 99-120.

Miller, C. S. and Ashford, N. A. "Multiple Chemical Intolerance and Indoor Air Quality," in *Indoor Air Quality Handbook*, J. Spengler, J. M. Samet, and J. F. McCarthy (Eds.), McGraw-Hill, New York, 2000, chapter 27, 32 pages.

Now available in pdf: "Public Participation in Contaminated Communities": http://web.mit.edu/ctpid/www/tl/TL-pub-PPCC.html.

Future planned activities include completion of textbooks on environmental law and policy; and globalization, technology, and sustainability. T&L program is directed by Professor Nicholas A. Ashford and involves Charles C. Caldart, CTPID Research Associate and Lecturer in Civil Engineering.

More information about this program can be found online at http://web.mit.edu/ctpid/www/tl/.

NEW BOOKS

Moavenzadeh, Fred et al. *Cities: Dynamics and Sustainability.* Kluwer Academic Publishers, 2001.

McKnight, Lee W.,William Lehr, and David D. Clark, editors. *Internet Telephony.* MIT Press, 2001.
Vogelsang, Ingo, and Benjamin Compaine, editors. *The Internet Upheaval: Raising Questions, Seeking Answers in Communications Policy.* MIT Press, 2000.

McKnight, Lee W., Paul M. Vaaler and Raul L. Katz, editors. *Creative Destruction: Business Survival Strategies in the Global Internet Economy.* MIT Press, 2000.

Napier, Joan, Denise Shortt, and Emma Smith. *Technology with Curves: Women Reshaping the Digital Landscape.* Harper Collins Publishers Ltd., 2000.

Camp, L. Jean. *Trust and Risk in Internet Commerce.* MIT Press, 2000.

Compaine, Benjamin M. et al. *Who Owns the Media?* Lawrence Erlbaum Associates, Third Edition, 2000.

Cutcher-Gershenfeld, Joel, Betty Barrett, et al. *Trabajo Impulsado Por El Conocimient* (Spanish translation of 1998's *Knowledge-Driven Work: Unexpected Lessons from Japanese and United States Work Practices*). Oxford University Press/Japan Business and Economics Series, 2000.

Eppinger, Steven D. et al. *Product Design and Development,* 2nd edition, Irwin/McGraw-Hill, 2000.

Sussman, Joseph. *Introduction to Transportation System.* Artech House Publishers, 2000.

VISITING SCHOLARS

Christopher Boutleiller, Professor of Finance at Reims Management School, France, and Catholic University of Louvain, Belgium, was a visiting scholar studying intangible asset assessment in the services industry.

Tetsuo Hojo, Professor at the Institute of Technologists/Nippon Steel Corporation, worked with Dr. Moavenzadeh on Technological Innovation in the Japanese Mega-Project.

Flavio Augusto Picchi, Director, Picchi Consultoria S/C Ltda, worked with Dr. Moavenzadeh in the area of Lean Thinking—Opportunities for the Construction Sector.

Kobe University Professor Kentaro Nobeoka worked with IMVP on network strategy and supplier management in the automobile industry.

Ki-Chan Kim, Director of the Institute of Industry Management and Associate Professor of Management at the Catholic University of Korea, joined IMVP to study aspects of automotive supply chains.

Geoff Bentley, Manager of Business Research at Textron Systems, Inc., was a LAI visiting scholar.

Lee McKnight, Director of the Edward R. Murrow Center at Tufts University holds an ongoing appointment with RPCP.

Sangho Park, Assistant Professor at Chungnam National University, Korea, worked with Dr. Daniel Whitney in the area on topics relating to Assembly Advisor.

PERSONNEL CHANGES

Su Chung was appointed Administrative Officer of CTPID in November of 2000.

LARA Co-Director Joel Cutcher-Gershenfeld, a Sloan senior research scientist, was appointed Executive Director of the Engineering Systems Learning Center.

TRIBUTES

Lean Sustainment Initiative Director Wesley Harris, professor of aeronautics and astronautics, received a Leadership Award at MIT's 27th annual Martin Luther King celebration in February. This year he was also elected as a graduate alumni trustee of Princeton University.
Dave Clark was awarded the Istitute of Electrical and Electronics Engineers (IEEE) 2000 Award for Public Service in the field of telecommunications for outstanding service to governmental bodies in helping them understand the Internet and its applications for the betterment of society.
Fred Moavenzadeh, James Mason Crafts Professor of Engineering Systems and Civil and Environmental Engineering, is center Director; Patricia Vargas is Assistant Director. CTPID's 17-person faculty council, which

provides intellectual oversight and liaison with academic units across MIT, includes leaders from the School of Engineering, the Sloan School of Management, Lincoln Laboratory, and MIT's Office of Corporate Relations.

FUTURE PLANS

United Nations Development Programme Administrator Mark Malloch Brown, who also serves as Chair of the United Nations Development Group, has accepted CTPID's invitation to speak on technology and development at MIT. Plans are underway to host his visit and lecture.

A new research initiative headed by Professor Tom Eagar, Materials Engineering, will bring together multi-disciplinary faculty from the Boston area to focus on science and technology components of contemporary environmental issues. The Program in Environmental Studies (PIES) is being developed in conjunction with CTPID and LFEE and is the successor to CTPID's Technology, Business, and Environment Program (TBE). TBE was inactive after the retirement of Director John Ehrenfeld and the departure of Acting Director Jennifer Nash for a position at Harvard's Kennedy School of Government.

More information about the Center for Technology, Policy, and Industrial Development can be found online at http://web.mit.edu/ctpid/www/.

Fred Moavenzadeh

CENTER FOR TRANSPORTATION STUDIES

The Center for Transportation Studies (CTS) was established in 1973 to develop and coordinate the wide range of transportation-related activity at MIT. It provides a focal point for transportation education, facilitates transportation research, conducts an outreach program to the transportation industry, and encourages a sense of common purpose among the many departments, centers and laboratories involved in transportation and logistics at MIT.

On the center's web site, there is a wealth of information about the center and its programs In addition, the site includes descriptions of current research projects in transportation, and a listing of MIT theses in transportation since 1980. Transportation faculty and research staff are also listed with their areas of interest, along with connections to other interesting resources on the web.

EDUCATION

Fourteen new students arrived on campus this fall to enter the center's new Master of Engineering in Logistics program, an intensive nine-month degree track preparing graduates for logistics management careers in manufacturing, distribution, retail, transportation and logistics organizations.

Again this year, because of the high quality of applications, qualifying for graduate admission for transportation studies was increasingly difficult. This year, 159 applications were received for graduate studies in transportation—including the Master of Science in Transportation (MST), the Master of Engineering in Logistics (MLOG) and the Ph.D. programs—and 78 students were enrolled in 2000–2001. Funding was found for 59 percent of the students.

RESEARCH

During the past academic year, almost 200 projects were posted on the center's current research listing, organized in ten categories and representing the work of more than 50 researchers in more than a dozen departments and research centers. Many of those entries were research programs which included within them still more individual projects.

MAJOR NEW PROJECTS

Collaborative Program with the Chicago Transit Authority

A collaborative research program has begun between MIT and the Chicago Transit Authority (CTA), aimed at helping the CTA leverage new technologies, urban development patterns and institutional funding structures to its best advantage. The program of research, strategic advice and professional staff development is inspired by the ongoing collaborative program involving MIT and the University of Puerto Rico in support of Tren Urbano, the introduction of a new urban rail system in San Juan.

To help the CTA make maximum use of all its potential, the research collaboration is focused on four primary areas—operations, facility design, decision support and future transit funding. MIT students are invited to develop research proposals in any of these topic areas—the work to be conducted in close conjunction with the CTA staff—and the ultimate product of each project will normally be a master's thesis.

During the first six months of the program, which began in January, two second-year masters students were included on a part-time basis, students who were already well along in their thesis research, and who could quickly contribute to the CTA research priorities. Their projects were Identifying Rail Line Strategies for Improvement, and Improving Connections between Transit Stations and Neighborhoods.

Meanwhile, seven MIT students are working as CTA interns in Chicago this summer, continuing research begun this spring on the following projects: Control Center Operations; Making the Connection at the CTA; Zoning Measures; Identification of Rail Line Strategies for Improvement; Contributing Factors and Control Strategies for Bus Bunching; The Economics of Transit in the Chicago Metropolitan Area; and Improving Access to CTA Rail Stations.

Those projects will continue this fall, and two new projects will begin: Impact on the CTA of Compliance With Americans with Disabilities Act (ADA) and Elderly Access Standards; and Effective Implementation of Bus Rapid Transit Systems. Other initial projects are Improving CTA Accessibility and Use by Bicyclists and A Multimedia Strategic Planning Tool for Rail Transit Infrastructure.

Driver 20/20 Explores Technology for Older Drivers

The AgeLab has undertaken a program of research called Driver 20/20 focused on whether, since older drivers have different cognitive and physical capabilities, the panoply of new information technologies in the car will actually be

of help to them. The program is the largest critical mass of effort in this area anywhere in the United States, outside of government efforts.

With funding through a consortium of the American Association of Retired Persons, Electronic Data Systems, Fiat, the Hartford Insurance, Peugeot and Volkswagen, the program is something of a new brand of Intelligent Transportation Systems (ITS) research—a convergence of social issues with digital technology, demographics and society. It is also bringing new range to the Center for Transportation Studies, involving new researchers from Aeronautics and Astronautics, Electrical Engineering, Computer Science, Management, and the Health Sciences—as well as people from the medical schools at Harvard, Tufts and Yale.

In general, the research is seeking to reconcile the auto of the future with the older driver of the future. To a large extent, the future of car manufacturers depends upon their success at differentiating their products. And because that is getting harder to do, many of them are developing cars that combine infotainment with their safety and security systems. But a potential problem arises here, stemming from the natural impulse to make use of new technologies without necessarily stopping to consider whether they're really needed, or what their downside might be. The AgeLab is trying to put the problem first, looking to see what the needs and preferences of the older driver might be.

System for Assessing Aviation's Global Emissions

A major new research program was begun with the Volpe National Transportation Systems Center and the Logistics Management Institute to develop a System for assessing Aviation's Global Emissions (SAGE). Sponsored by the Federal Aviation Administration, the program aims to create an internationally accepted computer model that can be used for predicting and evaluating the effects of different policy and technology scenarios on aviation-related emissions, costs, aircraft performance and industry responses.

The need for such a model is driven by the rapid growth in aviation and its associated emissions: it is estimated that in 1992, aircraft were responsible for 3.5 percent of all anthropogenic radiative forcing of the climate, a figure which is expected to grow to between 3 and 12 percent by 2050. But while the impacts of air transportation are global in scope, changes are costly and slow to incorporate. And there is currently no comprehensive methodology for determining global aviation-related emissions impact or for evaluating policy and technology alternatives at national or international levels. The SAGE model will be capable of analyses on aircraft, airport, regional and global levels.

MAJOR MEETINGS

Managing Inventory in the Internet Economy (November 28–29) featured speakers Tim Thomas, Health Imaging Director of Process Excellence, Eastman Kodak Company, and Sean Willems, Assistant Professor of Operations Management, Boston University ("Designing the Next-Generation Health Imaging Supply Chain"); Shelley Lin, Vertical IBSG Manager, Manufacturing Vertical, Cisco Systems ("Networking the Extended Enterprise for Supply Chain Success"); Ed Schuster, Director, Affiliates Program in Logistics ("Manufacturing Capacity vs. Inventory and Advances in Continuous Replenishment Systems"); Professor Steven C. Graves, Abraham J. Siegel Professor of Management, MIT Sloan School of Management ("Optimizing the Supply-Chain Configuration for New Products"); David Brock, Principal Research Scientist, Auto-ID Center, MIT Department of Mechanical Engineering ("The Internet of Things").

Global Logistics in the World Economy (March 14–15) featured speakers Hank Marcus, Professor of Marine Systems, MIT Department of Ocean Engineering ("Liner Strategies in the International Containership Industry"); Rob Quartel, CEO, FreightDesk.com ("International Freight Execution: The Black Hole in the Digital Supply Chain"); Richard Baron, Vice President, North America, e-Commerce Logistics ("Opportunities for Distribution of Branded Products in Asia/Pacific"); Ed Schuster, Director, Affiliates Program in Logistics ("A Review of Research and Trends in International Logistics"); Bruce Arntzen, Vice President, Supply Chain Sciences, Avicon Group, Inc. ("Creating Internet-Driven Supply Chains for Global Commerce"); Nariman Behradesh, Chief International Economist, Standard and Poor's ("The Outlook for the Global Economy in 2001: A Bumpy Odyssey").

SMALLER FUNCTIONS

Distinguished Speaker Series

The Distinguished Speaker Series featured the following: November 3, Fred Salvucci, MIT Senior Lecturer: "Observations on the Big Dig"; November 17, Robin Chase, CEO and Co-Founder, Zipcar: "Challenges of a Transportation Entrepreneur: Founding Boston's First Carsharing Organization."; December 1, Frank Kreusi, President, Chicago Transit Authority: "CTA in Motion"; December 8, Jeffrey Sriver, Manager, Resource Planning, Chicago Transit Authority: "Tokyo's Transportation System and What the US Can Learn from It"; March 2, Ben Hamilton-Bailie, Loeb Fellow 2001, Harvard Graduate School of Design: "Reconciling People, Places and Transportation—Stealing Ideas from Northern Europe"; March 9, Allan Kiepper, Principal Consultant, PB Consult: "The Human Side of Management"; March 16, Dr. Vukan R. Vuchic, UPS Foundation Professor of Transportation,

Department of Systems Engineering, University of Pennsylvania: "The Future of High Speed Ground Transportation: Prospects for Acela, High-Speed Rail and Maglev"; April 6, Don Pickerell, Chief Economist, US DOT Volpe National Transportation Systems Center: "Do Zero-Emission Vehicles Make Sense?"; April 20, John Bennett, Vice President, Transportation Planning and Policy, Amtrak Northeast Corridor Strategic Business Unit: "The Promise of High Speed Rail and the Challenge of Survival"; April 27, Marc Cutler, Vice President, Cambridge Systematics: "Twin Cities Ramp Metering Shutdown Study"; May 4, George Farrar, Associate, Booz-Allen & Hamilton: "BART to San Francisco Airport and Beyond: The Key Role of Community Outreach in Major Construction Projects"; and May 11, Richard Capka, Executive Director, Massachusetts Turnpike Authority: "Discussion of the Big Dig."

AgeLab Seminar Series on Technology And Healthy Aging
The following were part of the AgeLab Seminar Series: February 26, A.K. Nandakuman, Senior Health Economist, Abt Associates and Brandeis University: "International Demography of Aging—Facts, Challenges and Opportunities"; and March 12, Alessandro Coda, Centro Ricerche, FIAT: "Mobility for Everybody: Designing the Future of Transportation for the Disabled and Elderly."

Related Seminars
David Boyce, Transportation Laboratory, University of Illinois at Chicago: "Isn't it Time for a New Urban Travel Forecasting Paradigm?" (February 28, Experimental Study Group [ESG] Seminar Series).

Leif Johansson, President, AB Volvo, and CEO, Volvo Group: "Environmental Issues as Part of Business Strategy"(April 9, The Wallenberg Lecture on Sustainability and the Environment).

Joseph Sussman, Michael Gilat and Georges Darido: "Public Transportation, Mobility and the Environment in Mexico City" (April 10, Mexico City Project Spring 2001 Seminar Series).

Jonathan L.S. Byrnes, Chairman, Swift Rivers; former President, FastShip Atlantic: "FastShip: Developing a New Ocean Shipping Company" (April 25, Shipping Club Seminar).

Thomas Sattelberger, Executive Vice President and Member of the Board, Lufthansa German Airlines: "Virtuous Virtuality—The Practice of Airline Alliances and Other Current Aviation Issues" (May 9, MIT International Science and Technology Initiatives Seminar).

Transportation Research Board Reception for Students and Alumni
On January 8, the Center held its annual reception for students and alumni in conjunction with the Transportation Research Board (TRB) Annual Meeting. This year, the reception featured the authors of recent MIT books: Professor Joseph Sussman, *Introduction to Transportation Systems;* Professor David Simchi-Levi, *Designing and Managing the Supply Chain Concepts, Strategies, and Case Studies*; and Professor John B. Miller, *Principles of Public and Private Infrastructure Delivery.*

Open House for Students
An open house was held for prospective students in November to offer the opportunity to learn more about the center's degree programs in transportation, and to meet some of the faculty and staff.

AFFILIATES PROGRAM IN LOGISTICS

The Affiliates Program in Logistics was established in 1981 to develop relationships between MIT and the private sector transportation and logistics industries. The program helps support research which is of particular interest to private sector organizations and which contributes significantly to improved educational programs for private sector management.

Every year, one of the members hosts the rest of the group at a two-day meeting and tour of one of its facilities. This year the United Parcel Service (UPS) played host in October at their facilities in Louisville, KY. A total of 80 people, including members of the MIT program, guests and UPS staff, were on hand to hear presentations by senior UPS managers including Jim Kelly, Chairman and Chief Executive Officer, and Mike Eskew, Vice Chairman and Executive Vice President. The topics of the presentations ranged from an overview of the core 'small package delivery business', for which UPS is famous, to new business ventures designed to provide a wide range of eCommerce and logistics services. The program also included a presentation by David Simchi-Levi, newly appointed Professor of Engineering Systems at MIT, on trends in e-Commerce and supply chain management.

Four new firms joined the program this year: *Cisco Systems* is the worldwide leader in networking for the Internet, providing end-to-end networking solutions that customers use to build a unified information infrastructure of their

own, or to connect to someone else's network; *Lockheed Martin* is a global enterprise principally engaged in the research, design, development, manufacture and integration of advanced technology systems, products, and services for government and commercial customers; *W.R. Grace* is a global company with market-leading businesses in catalysts and silicas, construction products and container products; and *Shippers Network,* headquartered in Carlsbad, CA, was created in 1999 to establish a comprehensive, web-enabled transportation system designed to meet all the requirements of the shipping community.

INTEGRATED SUPPLY CHAIN MANAGEMENT PROGRAM

Since its inception in FY1995, the Integrated Supply Chain Management Program has grown to ten members—Avaya, Helix Technology, Intel Corporation, Lucent Technologies, Monsanto, Procter & Gamble, Siemens, Texas Instruments, Transcentric (previously Union Pacific Technologies) and Volkswagen AG. In addition to the 15+ research projects that had been initiated in the first six years of the program, the 2001 Program continued collaborative work with the Leaders for Manufacturing Program and the Center for Coordination Science. There were also 25+ collaborative exchange and senior executive events held at sponsor sites and the MIT campus.

PROFESSIONAL EDUCATION

Logistics and Supply Chain Management—eCommerce Meets eLogistics (July 17–21); Modeling and Simulation for Dynamic Transportation Management Systems (July 31– August 4); Public Transportation Service and Operations Planning (August 7–11); Airport Systems: Strategic Planning and Detailed Design (October 2–6); Internet-Based Supply Chain Management (January 31– February 2); Logistics and Supply Chain Management —Fundamentals and Thought Leadership (June 25–29).

PERSONNEL CHANGES

Meyer and D'Ambrosio joined the research staff. Two new researchers have been added to the center's staff to support the driving research at the AgeLab: Joachim Meyer, a human factors psychologist, and Lisa D'Ambrosio, a specialist in consumer behavior and survey research.

NEW FACULTY BOOKS

Principles of Public and Private Infrastructure Delivery by John B. Miller, Department of Civil and Environmental Engineering, was published by Kluwer Academic Publishers in November. The book puts project delivery, finance and operation together in a practical new formulation of how both public and private owners can better manage their entire collection of infrastructure facilities. In tracing the history of infrastructure development and finance in the United States, it provides the basis for a new, integrated strategy for managing infrastructure assets in the 21st century. New tools are presented that permit simple comparisons of different project delivery and finance strategies; practical approaches are provided that allow owners to compare capital program alternatives for entire collections of infrastructure facilities; and practical legislative strategies for organizing the delivery of public infrastructure are presented and described. It puts infrastructure asset management in an entirely new and more productive light, and establishes a new paradigm for steady improvement in the quality and cost performance of public and private infrastructure networks.

Moshe Ben-Akiva traveled to Greece and Sweden this fall to partake of ceremonies related to two recent public distinctions. In Greece, he was awarded an honorary doctorate from the University of the Aegean, presented in conjunction with their autumn graduation, at which he addressed the class about the planning and management of transportation systems. In Sweden, he attended the Nobel Prize ceremonies as a guest of Daniel McFadden, winner of this year's prize in economics; Ben-Akiva was cited, along with MIT colleague Steve Lerman, in the announcement of McFadden's award.

Joseph Coughlin, founder of MIT's new AgeLab (and Director of the University Transportation Centers Program here) was asked by the Organization of Economic Cooperation and Development in Europe to lead an international task force on technology for older drivers—a three-year study by global experts on older adults and vehicle-based information technology. Coughlin also shared the podium this fall with the Keynote Speaker at COMDEX—Dick Brown, Chairman of the Board and CEO of EDS, a leading global information systems company—where they both discussed the future of transportation that is 'beyond e' (i.e., beyond the simple integration of novel ITS devices in the car to the next generation of innovative services to the driver).

Henry Marcus, Professor of Marine Systems in MIT's Department of Ocean Engineering, was appointed to the Marine Transportation System National Advisory Council (MTSNAC). Chartered by the Department of Transportation in January 2000, the Council serves as a non-Federal deliberative body to advise the Secretary on matters related to the marine transportation system—waterways and ports, and their intermodal connectors. The council consists of 26 members representing every element of our marine transportation system. Its objective is to promote a safe and environmentally sound, world-class marine transportation system capable of responding to

projected trade increases. Six subcommittees have been formed to address specific issues, and Marcus has been appointed Co-Chair of research and development and information technology, responsible for identifying relevant R&D projects to support the MTS vision. Marcus has also been appointed a member of the Federal Transportation Advisory Group created in June 2000 by Deputy Secretary of Transportation Mortimer Downey.

David Simchi-Levi's new book *Designing and Managing the Supply Chain* (with P. Kaminsky and D. Simchi-Levi, Irwin/McGraw-Hill, IL, 1999) won the Book-of-the-Year Award, and Outstanding IIE Publication Award, given in 2000 by the Institute of Industrial Engineers. The book provides state-of-the-art models, concepts and solution methods important in the design, control, operation and management of supply chain systems. In particular, it attempts to convey both the intuition behind many key supply chain concepts, and to provide simple techniques which can be used to analyze various aspects of the supply chain. The book was written to serve as a textbook for MBA-level logistics and supply chain management courses, as a textbook for BS and MS industrial engineering courses on logistics and supply chain management, and as a reference for teachers, consultants and practitioners involved in any one of the processes that make up the supply chain. It includes two software packages — the *Computerized Beer Game* and the *Risk Pool Game* — which help to illustrate many of the concepts discussed in the book.

The New England University Transportation Center (UTC) at MIT chose Jennifer Farver, PhD candidate in transportation, as its UTC Outstanding Student of the Year 2001. Ms. Farver was selected in a regional competition that included graduate students from MIT, Harvard and the six New England state universities. She was honored, along with all of the national UTC award winners, at a US Department of Transportation (DOT) special awards ceremony in Washington DC in January. Ms. Farver also received a $1000 cash prize for this honor. She is a doctoral candidate in the Algorithms and Computation in Transportation Group under the supervision of Professor Ismail Chabini. Her master's thesis is in the area of dynamic traffic assignment with an emphasis on analytical, continuous-time dynamic network loading and dynamic shortest paths algorithms for a particular class of input functions.

MIT students Ryan Park and Michael Gilat were among those honored at a recent awards ceremony for a National Bus Rapid Transit Vehicle Design Competition focused on high-capacity buses to help relieve congestion and crowding. The new style buses, to be used in high-capacity 'bus rapid transit systems' demonstrate how new bus designs can be integrated with imaginative approaches to transit to better serve communities across America. Concepts from the winning designs will be integrated into several bus systems throughout the country. The competition was co-sponsored by the Federal Transit Administration and Westart, a non-profit corporation dedicated to encouraging the design and implementation of new transportation technologies that are environmentally responsible and improve the quality of life.

More information about the Center for Transportation Studies can be found online at http://web.mit.edu/cts/.

Yossi Sheff

CONCOURSE

Concourse is a highly structured and integrated program for freshmen covering the standard core curriculum in mathematics, physics, chemistry, and humanities. The structure of Concourse follows that of the standard curriculum with scheduled lectures, recitations, problem sets and quizzes. Small class size (limited to 60 students) and extensive personal interaction with senior faculty and tutors provide students with the intimate atmosphere of a small school rather while retaining all of the excitement and resources of a large institution like MIT.

For the fall term, 49 freshmen enrolled in Concourse, a 7.5 percent decline from the previous year. Enrollment for spring term was 24, a 60 percent increase from the spring of 2000. For the Independent Activities Period, 13 students registered for Concourse's 12-unit HASS course, 21W.731 Writing and Experience. From the Concourse Program, 59 percent of the students went on to majors in the School of Engineering; 22 percent to majors in the School of Science; six percent to Architecture and Planning; seven percent to the Sloan School of Management; four percent to Humanities, Arts, and Social Sciences; and two percent remained undesignated.

There were some changes in our curriculum this year. During the fall, 18.01 was replaced with 18.01A/18.02A. In chemistry, a new experimental syllabus, using a more physical approach with applications to modern biology was adopted. The class 21W.731 Writing and Experience, was offered for the first time over the Independent Activities Period; and, in the spring, 21W.746 Humanistic Perspectives on Medicine.

Future plans include allowing Concourse alumni(ae) to register for HASS and HASS-D courses after their freshman year; and, to develop a program similar to the Burchard Scholars, with regular meetings and retreats with specific academic and intellectual objectives, to be awarded to groups of applicants each year. The support for such a program would be solicited from an external source.

Members of the Concourse faculty for 2000–2001 were: Roberta Brawer, Lecturer, School of Engineering and Anthropology; Dr. Shepard Doeleman, Research Scientist, Haystack Observatory; Dr. John Lewis, Senior Lecturer, Mathematics; Dr. Kevin Rhoads, Lecturer, School of Engineering; Evelyne Robidoux, Lecturer, School of Science; Professor Robert M. Rose, Department of Materials Science and Engineering; Dr. Judah L. Schwartz, Professor Emeritus, School of Engineering; Dr. Christopher Sawyer-Laucanno, Writer-in-Residence, Program in Writing; and Dr. Jeremy Wolfe, Visiting Associate Professor, Department of Brain and Cognitive Sciences. Sixteen MIT undergraduates in the fall and ten undergraduates in the spring were employed as teaching assistants for recitations, grading, and evening tutorials in chemistry, physics, calculus and differential equations.

The Concourse Program was overseen by Robert M. Rose as Director and Ms. Cheryl Butters of the School of Engineering as Program Coordinator.

More information about Concourse can be found online at http://web.mit.edu/concourse/.

Robert M. Rose

INDUSTRIAL PERFORMANCE CENTER

The MIT Industrial Performance Center (IPC) is dedicated to the study of industries in the United States and in other advanced economies. The center brings together the intellectual resources of MIT in a search for fresh insights into the nature and origins of successful industrial performance. Through our research we seek to help leaders in business, labor, government, and the universities better understand global industrial development and to work with them to develop practical new approaches for strengthening public policies, business strategies, technical practices, and educational programs. With the participation of about 30 faculty members and more than 50 students from the Schools of Engineering; Management; Humanities, Arts, and Social Sciences; and Architecture and Planning, the center today serves as a listening post on industry, monitoring and interpreting industrial trends, techniques, and patterns of organization.

EDUCATIONAL PROGRAM HIGHLIGHTS

In Academic Year 2000–2001, the IPC awarded three new doctoral fellowships. Doug Fuller received a Fellowship to carry out his research on the role of Western Corporations in the Development on China's Technology-Based Industries. Danny Breznitz was awarded a Fellowship to pursue his comparative research on Entrepreneurship and State Policymaking in Emerging Industries in Israel, Ireland, and Taiwan. Raquel Gomes received a Fellowship for her studies of Brazilian Fruit Growers and Their Relationship to the Global Economy.

During this past academic year the center continued to sponsor a faculty seminar on "The Entrepreneurial, Global University." The seminar examines the social, economic, and technological trends that are reshaping the higher education industry and that may ultimately redefine its role in society. It is designed to serve as a forum in which leading members of the MIT community and the Boston-area academic community more broadly can consider the full range of these developments and reflect on their implications for strategy and practice.

RESEARCH HIGHLIGHTS

The center's research is organized around three major themes: Technology and the Changing American Workplace; Systems and Strategies for Innovation; and Globalization and its Implications for Industries and Societies.
The center continues its major research program on globalization. The term 'globalization' refers to the set of changes in the international economy that are tending towards the creation of a single world market for capital, goods, and services. In each of these dimensions, globalization raises new challenges for sustaining innovation, growth, societal well being, and broad political legitimacy in the nations it encompasses. The IPC Globalization Study focuses on one aspect of these developments: the fragmentation of the production systems of firms in the advanced economies, and the relocation of parts of these enterprises to other societies. Research on this topic is currently underway in the United States, Europe, Japan, Mexico, China, Taiwan, Indonesia, Thailand, Malaysia, and Latin America. The IPC Globalization Study team is led by Professor Suzanne Berger (Political Science), and also includes Professors Tayo Akiwande (Electrical Engineering and Computer Science [EECS]), Don Lessard (Sloan), Richard Lester (Nuclear Engineering), Richard Locke (Sloan), Michael Piore (Economics), Charles Sodini (EECS), Edward Steinfeld (Sloan), and IPC research associate Tim Sturgeon, and also includes research affiliates from Germany, Japan, and Taiwan.

A second IPC research initiative related to globalization was also launched this year. The new project focuses on the investment and contracting practices of multi-national corporations in emerging economies, the implications of these practices for sustainable economic development, and the role of labor and environmental standards and related codes of conduct. The central questions that the study seeks to understand are: in what circumstances is sustainable economic development facilitated by the interaction between multi-national corporations and host countries, and in what circumstances is it distorted or suppressed? Under what conditions does the application of international standards stifle growth and development, and conversely when do such standards promote industrial upgrading, productivity gains, and increased competitiveness? How effective are private and non-governmental attempts to monitor business practices and codes of conduct in relation to traditional government regulations? Participating faculty include, in addition to those mentioned above, Professors Joshua Cohen (Political Science), Thomas Kochan (Sloan), Robert McKersie (Sloan), Dara O'Rourke (Urban Studies and Planning), Judith Tender (Urban Studies and Planning), and Balakrishnan Rajagopal.

In April, the Industrial Performance Center organized the first national conference of the Sloan Industry Centers network, on "Corporate Strategies for the Digital Economy." The conference, which attracted nearly 300 academics, industrial practitioners, and policymakers to Cambridge, presented new research on corporate responses to technological change in a wide range of industries in domains such as research and new product development, logistics, the organization of supply chains, and the delivery of services.

Visitors to the IPC this year included Dr. Ji-Ren Lee, Professor of Management at National Taiwan University and Dr. Hervé Dumez, Research Professor at École Polytechnique in France.

More information on the Industrial Performance Center can be found online at http://web.mit.edu/ipc/www/.

Richard K. Lester

INTEGRATED STUDIES PROGRAM

The Integrated Studies Program (ISP) offers a curriculum for first-year students built around the study of technologies as they are practiced in different cultures and historical periods. ISP promotes a form of education that seeks to show students the connections among ideas and processes in sciences, humanities, and social sciences. Hands-on learning complements the theoretical work that is a typical component of most first-year coursework. ISP strives to provide students the academic and social foundation for success at MIT and beyond by creating a community devoted to team approaches to design and problem solving, inquiry, enhanced communication skills, and life-long learning.

PROGRAM HIGHLIGHTS

ISP's fall and spring HASS-D subjects were team-taught by Professor Arthur Steinberg, Dr. Peter Dourmashkin, and Ms. Frederica Steinberg, with the assistance of a variety of guest lecturers and workshop facilitators. In these subjects, students explored the relationship between technologies and the cultures in which they developed. Mr. Daniel Krynytzky, a visiting architect from California, spent a month in residence at ISP to develop and teach a unit on design. Under his guidance, students studied the design and construction of MIT's Stata Center, and experimented with principles of design by building paper hats and cardboard furniture. Other modules focused on food production and metalworking. Mr. Toby Bashaw ran a series of smithing workshops to complement a classroom unit focused on the tradition of the Samurai in Japanese culture.

Ms. Amy Smith worked with ISP faculty and staff to develop a new module on appropriate technologies as part of the spring HASS-D course. Students worked in teams to test the efficiency and cultural appropriateness of a variety of cooking stoves from around the world. Their projects culminated in a web page publishing their results and in oral presentations by the teams. Ms. Farzana Mohammed, an MIT graduate student and ISP alumna, assisted in the design and teaching of the module. Dr. Dourmashkin developed a new spring module to study how to recycle old computers.

ISP continues to focus attention on developing a strong writing curriculum under the leadership of Ms. Steinberg, with assistance from Ms. Debra Aczel. Students in the fall and spring HASS-D subjects wrote several papers of increasing length and sophistication; produced outlines, rough drafts, and abstracts; and spent considerable time working with writing graders/tutors to revise papers. Students receiving a grade of "B" or better were able to use the subjects to satisfy Phase I of MIT's Writing Requirement.

ISP hosted a weekly luncheon for freshmen with speakers from MIT and the greater community to discuss their work.

Students attended lectures in math and science subjects with the rest of the freshmen class, but were able to choose ISP-sponsored recitations in some subjects. Most students enrolled in 8.01x and 8.02x, experiential physics courses.

STAFF AND ENROLLMENT

ISP welcomed new administrative assistant, Ms. Ruth Weinrib. Ms. Debra Aczel was the program administrator.

ISP enrolled 24 students (16 male, 8 female) in fall and 25 students (17 male, 8 female) in spring.

More information about the Integrated Studies Program can be found online at http://web.mit.edu/isp/www/.

Arthur Steinberg

LABORATORY FOR COMPUTER SCIENCE

The MIT Laboratory for Computer Science (LCS) is an interdepartmental laboratory whose principal goal is to create computer-communications technologies of high social utility with equal attention to forefront technological underpinnings and human utility.

Founded as Project on Mathematics and Computation (Project MAC) in 1963, the laboratory developed one of the world's earliest time-shared computer systems: the Compatible Time Sharing System (CTSS) and its successor, Multics, which laid the foundation for many of today's systems and approaches, such as virtual memory, tree directories, on-line scheduling algorithms, line and page editors, secure operating systems, access control techniques, computer-aided design, and two of the earliest computer games, space wars and computer chess. Our partner in the Multics effort, AT&T, used many of the early ideas in their design of Unix.

These early developments laid the foundation for the laboratory's work on knowledge based systems—the Macsyma program for symbolic mathematics—natural language understanding, and (with Bolt Beranek and Newman Inc. [BBN]) the development and use of packet networks in the Arpanet. In the late 1970s, Project MAC, renamed as the MIT Laboratory for Computer Science, embarked on research in clinical decision making, public cryptography, distributed systems and languages and parallel systems. These led to the RSA encryption algorithm, data abstractions which served as foundations of object oriented programming, the Clu and Argus distributed systems, the dataflow principle and associated languages and architectures of parallel systems (Monsoon, Id and StarT), local area networks, program specification and workstation development, where the laboratory contributed the earliest UNIX ports and compilers and the Nubus architecture. This research also led to the X Window System, a computer intercommunication and user interface system which was further developed by the Laboratory's X-Consortium and was widely used in over one thousand different software products. Since 1994, LCS has been the principal host of the World Wide Web Consortium (W3C) of some 450 organizations that helps set the standard of a continuously evolving World Wide Web (W3).

The laboratory's current research falls into four principal categories: information infrastructure and distributed systems; human-machine interaction; science and computer science research; and theory.

In the areas of information infrastructure and distributed systems, we wish to understand principles and develop technologies for the architecture and use of highly scaleable information infrastructures that interconnect human-operated and autonomous computers. Transactions among such distributed systems involve the purchase, sale and free exchange of information and information work toward electronic commerce and shopping, health care, education, business, government, and many other uses as well as increased automation of human work. We wish to explore new emerging forces such as collaboration across space and time and automation of computer-to-computer actions. We also expect this overall research to have a broad impact on future systems because virtually every machine will be connected to some information infrastructure and such infrastructures are expected to last for a very long time. The laboratory's World Wide Web Consortium is a significant and major focus of our work in this area.

In the human-machine interaction area, our technical goals are to understand and construct programs and machines that have greater and more useful sensory and cognitive capabilities so that they may communicate with one another and with people toward useful ends. The two principal areas of our focus are conversational spoken dialogue systems between people and machines and graphics systems used predominantly for output. In this area, we also strive to construct tomorrow's servers by harnessing the power and economy of numerous processors working on the same task; relevant research spans parallel hardware and software architectures, that yield cost-performance improvements of several orders of magnitude relative to single processors.

In the science and computer-science area, we are interested in exploring opportunities at the boundary of traditional science and information technology. Our research includes an extensive program of clinical decision systems research between medicine and computer science, and several research activities in biology and computer science.

Taken together, these three thrusts define the laboratory's overarching goal: development, understanding, and better human communication with tomorrow's information systems. In the laboratory's fourth category of research, theory, we strive to discover and understand the fundamental forces, rules, and limits of information science and technology. As a result, theoretical work permeates our research efforts in the other three areas; for example, in the

pursuit of parallel algorithms, fault tolerant computer networks, and privacy and authentication of communications. Theory also touches on the logic of programs, the inherent complexity of computations, and the use of cryptography and randomness in the formal characterization of knowledge. The laboratory expends a great deal of effort in theoretical computer science because its impact upon our world is expected to continue its past record of improving our understanding and helping us pursue new frontiers with new models, concepts, methods, and algorithms.

HIGHLIGHTS

Oxygen Project

Oxygen is a project aimed at inventing and developing pervasive human-centered computers. It pulls together an abundance of technological resources toward creating a new breed of systems that cater to human–level needs, rather than machine-level details. Defense Advanced Research Projects Agency (DARPA) is a participant in its funding, as are six companies—Acer, Delta, Hewlett Packard, Nokia, NTT, and Philips—that share the project's goal and comprise the Oxygen Alliance. The project's duration is five years and occupies about one third of the LCS and Artificial Intelligence (AI) Lab (which collaborates with us toward the same goal). During the reporting period, Oxygen gave rise to multiple results, notably to the use of localization techniques and intentional naming to identify system resources; the us of a speech interface that permitted several research to start combining their research interests with spoken language; face recognition; collaborative work across space and time; and automation. Oxygen is a broad project, an integrative effort that cuts across the lab's four principal categories of research of LCS.

Cricket

The Network and Mobile Systems (NMS) group has designed, implemented and evaluated "Cricket," a location-support system for in-building, mobile, location-dependent applications. It allows applications running on mobile and static nodes to learn their physical location and orientation by using "listeners" that hear and analyze information from "beacons" spread throughout the building. Cricket is the result of several design goals, including user privacy, decentralized administration, network heterogeneity, and low cost. Rather than explicitly tracing user location, Cricket helps devices learn where they are and lets them decide whom to advertise this information to; it does not rely on any centralized management or control, and there is no explicit coordination between beacons; it provides information to devices regardless of their type of network connectivity.

Spoken Language Systems

This group has recently decided to offer open source license for their Galaxy Communicator architecture for conversational systems, so that institutions worldwide can adopt this standard without encumbrance. While the group continues to conduct dialogue modeling research in order to support increasingly complex applications such as air travel planning, they also are starting to develop a set of tools that will enable developers and users to implement their own, simpler applications. These light systems, as they are called, will be particularly useful in the development of the Oxygen system.

World Wide Web Consortium

As of this report, 525 organizations have joined the consortium in order to participate in and contribute to the orderly evolution of the W3. With three hosts and 10 offices worldwide, the W3C is growing in influence, as offices succeed in promoting W3C work in specific regions. Key W3C technical developments include the advancement of the Scalable Vector Graphics (SVG 1.0) Specification to Proposed Recommendation. SVG delivers two-dimensional vector graphics and mixed vector and raster graphics to the Web in XML (Extensible Markup Language), ensuring accessibility, dynamism, reusability, and extensibility. During this reporting period, as the consortium size increases, it is facing, increasingly, the challenge of balancing a broad-based consensus for standards versus "driving" the web forward based on technological capabilities and opportunities.

ORGANIZATIONAL CHANGES

Ms. Rachel Oberai-Soltz has joined the lab as Director Industry Partnerships with responsibility for both LCS industry relations as well as relations with the Oxygen partners.

DISTINGUISHED LECTURE SERIES

The laboratory's Distinguished Lecturer Series included presentations by Michael Stonebraker, Chief Technology Officer, Cohera Corporation; Robert Brodersen, Professor, University of California, Berkeley; Mark Horowitz, Professor, Stanford; and Lawrence Lessig, Professor, Stanford.

The laboratory is organized into 19 research groups, an administrative unit, and a computer service support unit. The laboratory's membership comprises a total of 440 people, including 109 faculty and research staff, 193 graduate students, 46 undergraduate students, 60 visitors, affiliates, and postdoctoral associates and fellows, and 32 support staff. The academic affiliation of most of the laboratory's faculty and students is with the Department of Electrical Engineering and Computer Science. About 38 percent of the laboratory's funding comes from the U.S. Government's Defense Advanced Research Projects Agency. The laboratory is also funded by and has extensive links with industrial organizations. These include partnerships for the construction of major systems such as the Oxygen Alliance, and consortia for the development of standards, such as the World Wide Web and the Oxygen Alliance.

More information on Laboratory for Computer Science can be found online at http://www.lcs.mit.edu/.

Michael L. Dertouzos

LABORATORY FOR ELECTROMAGNETIC AND ELECTRONIC SYSTEMS

The mission of the Laboratory for Electromagnetic and Electronic Systems (LEES) is to be the focus for research and teaching in electric energy from its production through its processing to its utilization, and in electromechanics from the macroscopic through the microscopic levels. Electric energy and electromechanics are defined broadly to include power systems monitoring and operation; automatic control; power electronics; high voltage engineering; and conventional, continuum and biological electromechanics. Much of the work of the laboratory is experimental, and industrial sponsorship represents a large fraction of the laboratory's support. The laboratory's professional staff consists of seven faculty from EECS, one Principal Research Engineer and two Research Scientists, and approximately 50 graduate students. The laboratory faculty and most of the staff are heavily involved in both undergraduate and graduate teaching. Faculty from the Departments of Mechanical Engineering (ME), Chemical Engineering (CE), Materials Science and Engineering (MS&E) and Nuclear Engineering (NE) are collaborators in many of the laboratory's programs, and there are extensive joint activities with the Microsystems Technology Laboratory (MTL) and the Laboratory for Information and Decision Systems (LIDS).

During the past year the laboratory has experienced an 11 percent increase, to 51 companies, in its Consortium on Advanced Automotive Electrical/Electronic Components and Systems (the "Automotive Consortium") membership, demonstrated several new technologies for improving the reliability and capacity of electric utility systems, demonstrated for the first time a magnetic field based nanoactuator, developed an innovative design for an electromechanical automotive valve train, and demonstrated "Talking Lights" in the Spaulding Rehabilitation Hospital as an assistive device for the blind, hard-of-hearing, and brain injured patients. LEES also received an IR100 Award for innovative product design, and one of its staff members received the Institute of Electrical and Electronics Engineers' (IEEE) Outstanding Young Power Electronics Engineer award.

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS

Professor John G. Kassakian, Principal Research Scientist Dr. Thomas A. Keim, and Research Scientist Dr. David Perreault lead the laboratory's work in automotive electrical and electronic systems. This work is sponsored primarily through the laboratory's Consortium on Advanced Automotive Electrical and Electronic Components and Systems. The consortium membership now numbers 51, an increase of five from one year ago, and membership is truly global, with more Asian-based member companies than North American companies, and a substantial European representation as well. Almost all of the world's major automobile manufacturers and component suppliers are members. The consortium has facilitated international working groups addressing issues of safety, battery/connector design, and arcing faults, all challenges that must be met for the deployment of advanced 42-Volt electrical systems.

Professor Kassakian, Dr. Keim, and graduate student Woo Sok Chang have developed an innovative electromagnetic valve drive. This new design minimizes electric power requirements and provides soft landing as an inherent feature of the design, rather than as an objective to be achieved by control system action.

Dr. Keim, Professor Zahn, and graduate student Alan Wu have completed an investigation of intermittent arcs in high-voltage automotive electrical systems. This work showed that arcs in 42-Volt electrical systems typically dissipate 50 or 100 times as much energy as arcs in 14-Volt systems. This work, along with parallel work by Jeremy Patterson at Tyco Electronics, was presented at a consortium meeting in Nagoya. As a result of this work, arc behavior is widely appreciated as one of the most important elements in the design of 42-Volt systems, and the industry is rapidly developing elegant solutions to this challenge.

Over the last two years, Dr. Perreault and graduate student Timothy Neugebauer have focused on the design of dc/dc converters for automotive applications using Computer Aided Design (CAD) optimization methods. A highly optimized dc/dc converter for automotive applications has been developed using these new methods. It is less than one quarter the size of prototypes previously developed in the lab, and prototype units will soon be delivered to over 15 automotive consortium member companies.

The consortium held meetings in Nagoya, Japan, and Lisbon, Portugal in the past year. The meeting in Nagoya, co-hosted by Toyota, was an exceptional gathering. Attendance approached 300, and the technical content was quite high. The readiness of the Japanese supplier base was dramatized by an exhibition, organized by Toyota. The meeting in Lisbon, co-hosted by Visteon, was also a success. The exhibition at this meeting was limited to Visteon developments. The extent of the work by one company provided further evidence of the rapid progress of the technology.

Last year, we reported that graduate student Edward Lovelace, Dr. Thomas Keim, and Professor Jeffrey Lang, in collaboration with Professor Thomas Jahns of the University of Wisconsin, had proposed and designed a high-power starter-alternator for automobiles of the future. That new machine promised to be more compact, more efficient and less expensive than separate scaled-up versions of traditional starters and alternators taken together. During this past year, in collaboration with the Ford Motor Company, we constructed an experimental starter-alternator, and graduate student David Wentzloff is now in the process of testing it. Our initial test results support the promise of improved performance.

MODELING, MONITORING AND CONTROL OF POWER SYSTEMS

Utility industry restructuring has placed an intense focus on achieving economically optimal system operation by employing new and more sophisticated control and monitoring strategies. LEES has been making significant contributions to the solutions of problems of power system modeling, economic control, and apparatus monitoring.

Monitoring of Power Apparatus and Systems

Professor Steven Leeb, in collaboration with Professor Les Norford in the Architecture department, has initiated an aggressive monitoring program to identify conservation opportunities that could mitigate problems with the electric utility in California. This program is funded in part by the California Energy Commission. Ten sites in San Francisco and Los Angeles will be monitored using the nonintrusive load monitoring (NILM) technology developed by Professor Leeb's group. The NILM provides quick, inexpensive installation and data collation, and is proving to be an ideal platform for power quality monitoring and electromechanical system identification. During the past year, students in Professor Leeb's research group have added networking and diagnostic capabilities to the NILM. The NILM can identify improper or inefficient operation of the electromechanical plant in buildings and report this information anywhere in the world via the worldwide web. This information is being used at MIT to identify significant opportunities to improve the efficiency and reliability of the electric service and electromechanical plant (e.g., Heating, Ventilating, and Air-Conditioning (HVAC) installations, in buildings). The first two NILM installations were conducted in San Francisco and Los Angeles in March 2001.

Research Engineer Mr. Wayne H. Hagman and his students, in concert with Entergy Corporation, have developed a method for predicting in real-time, up to fifteen hours ahead, the load-carrying capacity of power transformers used by electric utilities. Mr. Hagman and his students are presently implementing this method, in a field test installation, on two transformers in the New Orleans area. The installation will include a data link into the Entergy System Control Center to provide system operators with dynamic rating information for use in power dispatching decision-making.

A new method for the early detection of need-for-service and wear out which are applicable to power transformers and other oil insulated power apparatus has been developed by Dr. Chathan Cooke and his graduate student, Timothy Cargol. The goal for this work is the automated in-service detection of degradation of insulating oil used in power apparatus. Past experience indicates that trouble in the tap changer compartment is the most likely cause for transformer failure and hence the focus of this effort is on the tap-changer. A demonstration system for the specific example of tap-changer oil in a power transformer has been constructed, lab-tested and recently installed on an operating transformer on the network of Entergy Services Inc. This system incorporates automated operation and network communications to enable significant cost savings as well as more reliable operations. The in-service performance of the automated diagnostics will be evaluated during the next year.

Modeling of Power Systems

Professors George Verghese and Bernard Lesieutre, along with their students, have been extending their study of a model they introduced last year for networked Markov chains whose transitions are influenced by the states of their neighbors. This "influence model" combines analytical tractability with an ability to capture some of the structure that is of interest in studying networked systems. The effort is being carried out under a U.S. Air Force Office of Scientific Research University Research Initiative (AFOSR URI) grant awarded this year to MIT (jointly with Stanford, University of Illinois—Urbana, and Caltech). The influence model has garnered significant interest from various researchers.

High Voltage and Insulation Research

Dr. Cooke and undergraduate student Daniel Santos are working on a project to reduce the adverse effects of transients and wind-driven fatigue on overhead power lines. Many in-service power lines fail due to mechanical high-cycle fatigue induced by Aeolian vibrations for wind speeds typically in the 5 to 10 miles per hour range. Extensive modeling for vibration modes and frequency dependent damping have been developed to represent typical vibrations versus wind speed. The goal is to introduce damping that reduces vibrational bending so that longer life operation can be achieved. Bench size models have been used to demonstrate the method and larger scale tests are being planned. In the next year wind-tunnel tests are planned to quantify the actual damping of a model line exposed to controlled winds and to demonstrate improved damping.

POWER ELECTRONICS AND ELECTROMECHANICS

Dr. Perreault and graduate student Joshua Phinney have completed development of a new filtering technique for power electronics that employs active tuning control. The new technique allows dramatic reduction in the size of the passive filter elements used in power electronics. Reductions of over a factor of three in size and weight as compared to conventional designs have been demonstrated. Dr. Perreault and Mr. Phinney have also developed a passive inductance cancellation technique that greatly improves the performance of power capacitors at high frequencies. Initial experiments have demonstrated over a factor of 10 improvements in noise suppression performance with this new design method, and much greater improvements are expected to be possible. Dr. Perreault and graduate student Albert Chow have developed a new active ripple filter method for power electronics. This new technique greatly reduces the size of filter capacitors needed in many power electronics designs, and may have particular value in aerospace applications where capacitor type and size is a critical factor. These new filtering approaches are expected to be valuable in a wide range of power electronics applications.

Professor George Verghese has co-edited (with Professor Soumitro Banerjee of IIT Kharagpur, India) an IEEE Press/Wiley book titled *Nonlinear Phenomena in Power Electronics: Attractors, Bifurcations, Chaos, and Nonlinear Control*, which contains contributions from around thirty authors (including several sections coauthored by Professor Verghese). This volume, which has just been published, is the first to be entirely devoted to nonlinear behavior in switched circuits. It has been tightly edited and contains an index, to increase its usefulness to researchers and practitioners in power electronics.

Professor Leeb's Talking Lights have been installed at the Spaulding Rehabilitation Hospital. The Talking Lights system uses conventional fluorescent lamps already in use for illumination in a building to create an inexpensive data network. A Talking Lights electronic ballast modulates the arc in a fluorescent light, transmitting information to an optical receiver with no visible flicker in the lamplight. At Spaulding Talking Lights are serving as assistive devices, providing location and wayfinding information for the blind, hard-of-hearing, and for brain injury patients.

Micro-Electromechanical Systems

Graduate student Hur Koser and Professor Jeffrey Lang, in collaboration with Professor Mark Allen and his students at the Georgia Institute of Technology, and many students, staff and faculty at MIT, have completed the design and fabrication of a new micro-scale magnetic induction motor. The first-generation motors exhibit torque densities equal to those of existing electric micro-scale motors, but without laminated stators. Second-generation magnetic motors, with laminated stators, are currently under development, and their torque densities are expected to greatly exceed those of the existing electric and magnetic micro-scale motors.

Graduate student Jin Qiu and Professor Lang, in collaboration with Professor Alex Slocum of ME, have designed, fabricated and demonstrated a new mechanically-bistable micromechanical mechanism. The mechanism is very simple to fabricate, and its characteristics are very easy to control. Therefore, it should have wide application to micromechanical relays, fasteners and memories. They are currently working to develop this mechanism into a solid-state relay suitable for use in low-voltage residential and commercial applications.

Professor Zahn has received a three-year program funded by the National Science Foundation to develop magnetic field based Micro-Electromechanical Systems (MEMS) and microfluidic technologies using 10 nm diameter single domain permanently magnetized ferromagnetic spheres with and without a carrier fluid. This research program will explore a new class of magnetic devices with such applications as nanoduct flows, pumps, and nanomotors. Another type of application being explored is the use of a wax based ferrofluid which is solid at room temperature but flows at slightly elevated temperatures. External magnetic fields can shape the material when fluid, and the shape is maintained when the fluid is cooled and the field removed. Such a process can, for example, be used to form nanogears or sharp needle-like peaks for charge injection devices. These formations have been demonstrated.

BIOELECTRONICS

Graduate student Tim Denison completed a Ph.D. thesis co-supervised by Professor Leeb this year involving the development of a new, super-low noise electrometer. In collaboration with researchers at Harvard and the Rowland institute, this electrometer was used to develop a nano-scale "Coulter Counter" that can be used to quickly identify DNA sequences passing through a pore in an electrochemical cell. This technique has been successfully demonstrated for a variety of identification scenarios, including the recognition of hybridized DNA strands consisting of unknown or "test" DNA bonded to probe strands.

HONORS AND AWARDS

Former Research Scientist Dr. David Perreault was hired by the Department of Electrical Engineering and Computer Science as an Assistant Professor. He is also the 2001 recipient of the IEEE's Richard M. Bass Outstanding Young Power Electronics Engineer award which recognizes outstanding achievement in the field of power electronics by an engineer less than 35 years old.

Professor Zahn has been awarded the Thomas and Gerd Perkins Professorship.

Professor Leeb received an R&D 100 award and was also awarded US Patent 6198230 for his Talking Lights technology.

More information about the Laboratory for Electromagnetic and Electronic Systems can be found online at http://web.mit.edu/lees-lab/www/.

John G. Kassakian

LABORATORY FOR INFORMATION AND DECISION SYSTEMS

The Laboratory for Information and Decision Systems (LIDS) is an interdepartmental laboratory for research and education in systems, communication, and control. It is staffed by faculty members, research scientists, postdoctoral fellows and graduate students drawn principally from the Department of Electrical Engineering and Computer Science, as well as the Department of Aeronautics and Astronautics, Mechanical Engineering and the Sloan School of Management. Undergraduate students participate in the research program of the Laboratory through the Undergraduate Research Opportunities Program (UROP). Every year many research scientists from various parts of the world visit the laboratory to participate in its research programs.

The research goal of the laboratory is to advance the field of systems, communication, control, and signal processing. In doing this, it explicitly recognizes the interdependence of these fields and the fundamental role that computers and computation play in this research. Specifically, the work conducted at LIDS falls into several areas. Research in the area of communications, networks and systems includes fundamental work on data networks, information theory, and communication theory. Systems research includes satellite communications, wireless communication, optical communications, and networks. Research in the area of estimation and signal processing includes work on multi-resolution statistical signal processing, robust estimation in the presence of non-normal noise, and the architecting and analysis of large-scale systems such as sensor networks. Research in the area of control ranges from theoretical issues such as robustness, aggregation, and adaptive control, to the construction of a computer-aided design environment for the control of unmanned air vehicles, the use of neural networks for approximating optimal controller designs and system identification and the study of natural neuro-control systems. Research in the area of algorithms includes analytical and computational methods for solving broad classes of optimization problems arising in engineering and operations research, and for applications in communication networks, control theory, power systems, computer-aided manufacturing, as well as issues on resource allocation and scheduling under uncertainty and neuro-dynamic programming. Research on perceptual systems and machine learning includes the problems of speaker-independent speech recognition, on- and off-line handwritten character recognition.

As an interdepartmental laboratory, LIDS reports to the Dean of the School of Engineering, Thomas L. Magnanti and the director of the laboratory is Professor Vincent W. S. Chan.

The Center for Intelligent Control Systems, an inter-university, interdisciplinary research center operated by a consortium of Brown University, Harvard University, and MIT. The center resides administratively within LIDS.

Twenty faculty members, several research staff and graduate students are presently associated with the Laboratory. LIDS currently has approximately 100 graduate students. Undergraduate students also participate in research and thesis activities. A number of postdoctoral and visiting appointments are made.

Financial support is provided by the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), the Cambridge University-MIT Alliance, the Defense Advanced Research Projects Agency (DARPA), Draper Laboratory, HP, Intel, Lockheed Sanders, Lucent-Bell-Labs, Merrill Lynch, Pierce, Fenner, and Smith, Inc., Motorola University Partnerships in Research, the Multiple University Research Initiative Program (MURI), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the National Reconnaissance Office (NRO), the Office of Naval Research (ONR), Siemens AG, Tellabs, Inc., and the Walsin-Lihwa Corporation.

The current research activities of the laboratory cover a wide range of theoretical and applied areas in systems, communications, control and signal processing.

COMMUNICATIONS

Data Communication Networks

The major objective of this work is to develop the scientific base needed to design data communication networks that are efficient, robust, and architecturally clean. Wide-area and local-area networks, high-speed and low-speed networks, and point-to-point and broadcast communication channels are of concern. Some specific topics of current interest are power control, the capacity of wireless channels with parallel relays, splitting and successive decoding for wireless networks, media access control protocols, routing in wireless and satellite networks, quality of service control, diverse traffic mixes, failure recovery, topological design, and the use of pricing as a mechanism for efficient resource allocation. Professors Dimitri P. Bertsekas, Vincent Chan, Robert G. Gallager, Muriel Medard, Eytan Modiano, Vahid Tarokh, John Tsitsiklis, Drs. John Chapin, Steven G. Finn, Charles Rohr, Milica Stojanovic, Peter Young, and their students are conducting this research.

Optical Networks

During the last year, Professors Vincent Chan, Robert Gallager, Eytan Modiano participated in a "Next Generation Internet" program funded by DARPA. The focus of the program is to design and prototype the next generation local and metropolitan area access network with orders (up to 4) of magnitude increase in data rate, but at the same time decrease the cost of delivery per bit by approximately the same amount. The network will use multiple wavelengths

(colors) to increase capacity and optical devices for routing and switching. One interesting architectural feature of the network will be an option for the user of the network to set up direct end-to-end optical flows for future applications with very large transactions (Gigabytes and beyond). The architecture design was successfully completed and a test network is deployed in eastern Massachusetts, with 10 Gbps access rate for users and well over a Tbps capacity. We have also connected this test network and others around the country to form SUPERNET a prototype for the Next Generation Internet. Because of the interdisciplinary nature of the research, LIDS is able to partner with members of Laboratory for Computer Science (Dr. David Clark), Lincoln Laboratory, AT&T, Cabletron, JDS Fitel, and Nortel.

Professor Eytan Modiano continues to work on an NSF grant to study mechanisms for providing optical bypass in the Next Generation Internet (NGI). The goal of the research is to use Wavelength Division Multiplexing (WDM) technology together with novel algorithms to reduce the size, cost and complexity of electronic switches and routers in the network leading to a dramatic increase in the traffic capacity that can be supported by the NGI. A new DARPA Grant on future optical network architectures has also been initiated this year. New collaborations with Lucent Bell Labs have also taken place.

Professor Muriel Medard is working on issues of reliability and robustness of backbone and access networks. Her first project is in the area of probabilistic analysis of optical network robustness as part of an AFOSR University Research Initiative (URI) with Stanford, University of Illinois, and Caltech. The work in this area considers robustness and security of all large network systems such as backbone communication networks and power grids. Other MIT researchers on this URI project are Professors George Verghese and Bernard Lesieutre.

Professor Medard is also working on reliability of access networks. She is the MIT member of a recent NSF Information Technology Research (ITR) with the University of Illinois in the area of robust optical local and metropolitan area networks. In particular, this project considers the use of course unit of measure (UOM) and limited signal-to-noise ratios (SNRs) in architecting robust networks.

Satellite Communications and Networking
The overall goals and objectives of this research addresses architecture designs for efficient data communications over low earth orbiting satellites (LEOS) (and other more generalized satellite systems) and especially when they are interconnected with terrestrial fiber and wireless systems to form a heterogeneous global Internet. There are three main components to this research:

- Adaptive power and rate control techniques for the LEOS systems over time-varying satellite channels to achieve greatly improved (an order of magnitude) data throughputs;
- Efficient routing algorithms over a time-varying integrated and heterogeneous global network for maximum resource utilization, especially the space segments; and
- Efficient congestion control algorithms at the transport and network layers for an integrated satellite/terrestrial network.

During the past year, research on the techniques for adaptive power and modulation control continued. We have been able to provide exact solutions for system performance gains, as a function of the speeds of the dynamics of rain events. The results look very promising for some simple form of power and rate control. To quantify the potential performance gains of optimum spot beam scheduling for bursty data users, we are assessing the fundamental capacity limit of a multiple spot beam antenna system against proposed and currently operational satellite systems. We found the performance of the current system designs very far away from their maximum potential and thus are suffering from extreme inefficiencies in the utilization of precious satellite resources. We have also began to look at optimum scheduling algorithms for multiple beam systems, coupled with efficient power management of space-borne multiple beam transmitters and receivers.

Initial work on routing congestion control over heterogeneous satellite and fiber networks has also begun. We feel this is a very rich area yet to be fully explored. Significant performance gains with the right algorithms are likely. Professors Vincent W. S. Chan, Eytan Modiano, John Tsitsiklis, Drs. Milica Stojanovic, Steve Finn, and Charles Rohr and their students are conducting this research.

Space Relay Networks
In the last six months we initiated a study on the preferred constellation topology of the space backbone. Based on coverage of space-borne users alone, the minimum number of satellites in the backbone constellation can be as small as 12 for LEO's, six for medium-earth orbiting satellites (MEO's) and the usual three for geostationary earth orbiting satellites (GEO's).

The fact that the crosslinks are reconfigurable via pointing and establishing new links between satellites allows a new paradigm in the architecture of the physical network topology. We believe reconfiguration of connection topologies permits much more efficient use of crosslink assets, especially in cases with a few data sinks, and thus may lead to significant cost savings for the complete system.

We also did a mini-study to reach a baseline understanding of current traditional space-qualified processors and commercial processors. It confirms the common believe that rad-hard processors are at least one order of magnitude

slower or approximately 7–10 years behind commercial processors. This suggests our view of replenishable-networked space-borne processors may lead to significant improvement of computation power in space. We have begun to look at the architecture of a networked processing system in space and the associated problem of task scheduling.

We continue to look at efficient message routing in space and confirmed that with optimum algorithms, significant performance advantage can be realized over conventional static routing approaches. Moreover, for the case of a large number of bursty lower rate users, such as unattended sensors, trying to gain access to the relay backbone, we have created a new multiple access technique that will greatly improve the efficiency of resource (e.g., communication channels) utilization of the satellites.

Finally, we believe there will be the need to send critical and time-sensitive messages to users in the field and to data processing and storage centers with a high degree of delivery guarantees. Part of the transport can touch commercial and defense networks that are not robust to natural breakage or attacks. Thus, we have proposed a technique to send critical messages over unreliable networks via spatial diversity coding.

Professor Muriel Medard is working in the area of capacity and stability of coded packetized multiple-access channels with students at MIT and with Professor Steven Meyer of the University of Illinois Urbana Champaign and Professor Andrea Goldsmith of Stanford. In particular, this research establishes the capacity of such channels and examines trade-offs between energy and delay. This research allows the un-coordinated access in satellite networks of multiple users without requiring total performance in the event of a packet collision. She is also developing with students an emulator; using code-division multiple-access (CDMA) standards of a practical implementation of such coded multiple-access channels.

Professors Vincent W. S. Chan, Robert Gallager, Eytan Modiano, Muriel Medard, Drs. John Chapin, Steve Finn, Charles Rohrs and Peter Young, and their students are conducting this research.

Communication Under Channel Uncertainty
Professor Medard has been investigating several issues in the area of wireless communications over uncertain channels. In collaboration with Professor R. Srikant at the University of Illinois Urbana-Champaign, she has investigated the effect of unequal channel knowledge at the sender and receiver. In particular, they have developed bounds to assess the effectiveness of applying techniques designed for certain idealized channel models to more channels with more detailed models. In collaboration with Professor Andrea J. Goldsmith of Stanford, she has investigated the capacity of time-varying channel with sender and receiver side information, in particular for channels with perfect side information but significant inter-symbol interference, for which no capacity formulas existed. In collaboration with Dr. Ibraham Abou-Faycal of Vanu Inc. and Professor Madhow of UCSB, she is working on the use of an adaptive modulator without feedback in which the sender adapts to the quality of the receiving channel measurement as well as the channel strength. This technique increases capacity by up to 30 percent without expressly supplemented energy and without requiring real time computation.

Codes On Graphs and Iterative Decoding
Sae-Young Chung completed his work under Professor G. David Forney, Jr. on graphs and iterative decoding algorithms. In joint work with Richardson and Urbanke, he devised optimization algorithms that were able to produce codes that could approach the Shannon limit within 0.0045 dB, with implementable decoding algorithms Professor Forney was an editor of the February 2001 special issue of the *Institute of Electrical and Electronics Engineers (IEEE) Transactions on Information Theory* on Codes on Graphs and Iterative Decoding. He also co-organized a Workshop on Capacity-Approaching Codes, Inference on Graphs, and Statistical Physics and the International Centre for Theoretical Physics in Trieste, Italy in May 2001. His current research interests include making connections between codes on graphs and their iterative decoding algorithms and methods of statistical physics.

Professor Muriel Medard in collaboration with Professor Rolf Koetter of the University of Illinois Urbana Champaign is working on an algebraic description of codes on graphs for data transmission over networks. All routing over a network can be described as a code over that network. Moreover, network capacity in error-free networking can be significantly enhanced through the use of codes over these networks. The research by Professors Koetter and Medard has developed a powerful new construct which when extended not only provides all the results previously obtained by graph theoretic methods, but also gives necessary and sufficient conditions for any set of connections to be feasible over a graph where we code. This research is also being extended to robustness when link nodes are permanently removed to the fundamental requirements of a network managed to recover from non-intermittent failures.

Quantum Information Theory
Yonina Eldar (Digital Signal Processing [DSP] Group), working with Professor Forney, has shown the "square-root" measurement of quantum detection theory is actually a "least-squares" measurement, from which many of its properties follow. She has also shown that there is an intimate correspondence between such measurements and the

"tight frames" of wavelet and signal representation theory, which allow various quantum mechanical results to be transported to frame theory. Recent results relate to geometrically uniform measurements and frames.

Wireless Communications
Professor Vahid Tarokh together with several students, have ongoing projects in various fields including mobile communications, switching, data networks, data security, applications of information theory to vary-large-scale integration (VSLI), and free space optical communications. Specific research includes: design of multiple antenna communications systems, peak to average power reduction in wireless optical frequency division multiplexing (OFDM), capacity achieving codes for wireless communications, distributed source coding, tracking fluid policies for crossbar switches, scheduling algorithms for input queued switches, coding for reduction of energy consumption and timing in buses, space-time coding for free space optical communications, hyper-elliptic curves cryptography, and measurement of multi-input multi-output (MIMO) wireless channels in collaboration with Lincoln Laboratories.

Collaboration With Tellabs and Draper Laboratory
The Laboratory for Information and Decision Systems and Tellabs Operations, Inc., a telecommunications equipment manufacturer, and Draper Laboratory are developing a novel approach to collaborative research. In this approach, LIDS, Tellabs and Draper Laboratories integrate industrial research interests within MIT's research and educational environment. The key difference between this new model of collaboration and traditional approaches is the focus on human resources as the primary enabler. Toward this end, LIDS provides Tellabs and Draper Lab with access to faculty, students, visitors, facilities, and infrastructure support, while Tellabs dedicates resident corporate research positions to the effort, assuming responsibility both for co-advising student research and for technology transfer as an internal corporate process. LIDS benefits from the persistent presence of industrial researchers, and Tellabs benefits from the leveraging of LIDS's staff. LIDS and Tellabs have been jointly working on this new research model for three years and look forward to its growth and refinement.

SYSTEMS, DETECTION, ESTIMATION AND OPTIMIZATION

Stochastic Systems Group
The Stochastic Systems Group (SSG) is led by Professor Alan S. Willsky, with the assistance of Research Scientist, Dr. John Fisher and Postdoctoral Researcher Dr. Mujdat Cetin. In addition the group includes 10–12 graduate students, visitors, and participants from other groups within LIDS and from other MIT laboratories and departments. The general focus of research within SSG is on the development of statistically based algorithms and methodologies for complex problems of information extraction from signals, images, and other sources of data. The work in the group extends from basic mathematical theory to specific areas of application. Current applications include automatic target recognition (ATR), biomedical image analysis, oceanographic and hydrological data assimilation, and fusion of multi-source (e.g., acoustic and video) information. Funding for this research comes from a variety of sources, including ONR, AFOSR, ARO, Office of the Director, Defense Research and Engineering (ODDR&E) (through AFOSR, ARO, and ONR), National Institutes of Health (NIH), and NSF.

In addition to directing these research activities, Professor Willsky is very active in supporting government and, in particular, Department of Defense organizations in assessing and planning technology investments. He is a member of the Air Force Scientific Advisory Board. Each of the following research areas being pursued within SSG involves both theoretical development as well as applied studies to the application areas mentioned previously.

Multi-Resolution Statistical Signal Processing
For some time now (and in part sparked by the flurry of activity associated with the wavelet transform) there has been considerable interest in algorithms for processing signals or images at multiple resolutions. SSG has played a leadership role in developing a statistical basis for such multiresolution processing that has had a significant impact as evidenced not only by the applications pursued within the group (in synthetic aperture radar based [SAR-based] ATR, oceanography and hydrology, and computer vision, for example) but also by the increasing use of our methodology by others in fields ranging from biomedical imaging to chemical engineering.

The key to this research area is the direct statistical modeling of phenomena at multiple resolutions using graphical models on trees and other graphs, in which each level on a tree corresponds to a particular resolution. We have developed very efficient algorithms for estimation, data fusion, and other image analysis tasks using these models and have also demonstrated, primarily through example and application, that a wide variety of real phenomena and applications can be captured within this framework. Because of this success, our current and planned efforts involve expanding the domain of applicability of our methodology, both by pursuing additional applications and by developing tools for constructing multiresolution models needed as the basis for applying our results.

Most recently we have increased our investigation on how we can exploit our methodology for problems involving much more complex graphical models as arise in military command and control or in problems of monitoring complex systems, a problem of great national concern because of its relevance to making critical national infrastructure secure. In particular our approach to modeling takes a very different perspective from most work on graphical models—we focus explicitly on developing accurate but approximate models that have structure that leads to very fast optimal algorithms, rather than most work on graphical models that involves trying to find tractable sub optimal solutions to exact graphical models that do not have structure that allows fast optimal inference. In the past year we have had several results in this area that represent significant advances in the state of the art in inference for

graphical models and in the distributed fusion of information from large collections of irregularly spaced and heterogeneous sensors. Our multiresolution methods are also a key component of a recently awarded $4.4M, five-year NSF-ITR program on large-scale data assimilation for geophysical processes which involves collaboration with MIT researchers in Civil and Environmental Engineering, Earth, Atmospheric, and Planetary Sciences, and Electrical Engineering and Computer Science. In addition, Professor Willsky has been invited to write a tutorial/survey paper on multiresolution statistical signal and image processing for the *Proceedings of the IEEE.*

Nonlinear and Geometric Image Analysis
During this past year we have continued our efforts in the area of nonlinear/non-Gaussian image analysis, including the explicit estimation/extraction of geometric information such as object boundaries and segmentation. Our work continues to focus on the development of statistically based curve evolution algorithms. Such algorithms involve explicitly defining and dynamically evolving curves in ways that lead to accurate and efficient segmentation of images. Methods of this type that had been developed by others had a number of very attractive features, including the fact that they provided seamless ways in which a curve could separate into multiple curves or merge from several disjoint curves to a single curve, allowing automatic and easy segmentation of multiple regions of interest. Our work is aims at developing first principles statistical approaches to curve evolution that deals with noise and variability in a statistically optimal way without sacrificing resolution. During this past year we have added to our suite of algorithms by developing curve evolution methods simultaneous image deblurring and segmentation as well as for the incorporation of prior statistical descriptions of the shapes of regions of interest in a way that is compatible with the curve evolution framework. This latter effort is part of our collaboration with clinicians and researchers at Brigham and Woman's Hospital toward the development of image guided therapy procedures for prostate cancer. In addition, we envision extending these efforts to examine problems of dynamically evolving curves and boundaries as part of the NSF-ITR effort mentioned previously, with the specific aim of developing radically new forms of data assimilation and prediction algorithms for geometric features such as fronts in meteorology and oceanography.

Machine Learning and Optimization Methods for Multisensor Fusion
The third component of our research program involves the development of statistically-based algorithms for the fusion of information from multiple sensors in the presence of substantial uncertainties—e.g., in the nature of the signals being sensed (e.g., acoustic signatures of unknown character), in the number of sources generating those signals, in the locations and calibration of the sensors themselves, and in the relationships among the signals being sensed by sensors of very different modalities. Our work to date has focused on the fusion of audio and video sensors, and the fusion of multiple acoustic sensors for the detection and localization of multiple sources, projects being carried out jointly with researchers in MIT's Artificial Intelligence Laboratory. Our work has already led to two invited journal papers, which are currently in progress.

Information-theoretic Methods in Image Analysis and Fusion
During this past year we have continued to increase our efforts in developing and using methods of non-parametric statistics for a variety of very complex image analysis and fusion problems. In particular, in our work on SAR-based ATR we have built non-parametric probabilistic models that capture statistically significant differences in the scattering response of different types of scatterers and then using these models to exploit these differences for feature extraction, enhancement, and recognition. We have also used non-parametric statistics together with the concept of mutual information to develop new approaches for functional Magnetic Resonance Imagery (MRI) studies in which we wish to correlate particular experimental protocols (e.g., a patient squeezes and then releases a ball) with brain activity so that mapping of brain activity to function can be performed. This work is interesting in that it involves fusing information of very different modalities (force applied to a ball and Magnetic Resonance Imagery). We have also used similar tools for the fusion of video and acoustic data and, in particular, for the localization of the sources of sound (e.g., human voices) in the video field of view.

Atmospheric Optical Communications
Professor Shapiro, in collaboration with Professor Chan and Dr. Wong (of the Research Laboratory of Electronics [RLE]) has been working on approaches to mitigate the effects of atmospheric turbulence on laser communications. A theoretical study of the use of space-time coding has shown that the same orthogonal-design approach that has been developed for conventional wireless communications also optimizes the pairwise probability of error for atmospheric optical communications using coherent detection. Work is presently underway to assess the capacity of direct-detection atmospheric optical communications. In conjunction with the theoretical studies, a laboratory test bed is being assembled as a prelude to performing diversity transmission experiments over outdoor paths.

Neurobiological Modeling
Professors Munther A. Dahleh and Steve Massaquoi are interested in two problems. The first is the development of a hierarchical model of the interaction between the cerebrum and cerebellum that is anatomically justified that can explain two-dimensional arm motions. The second problem is deriving a multi-scale, multi-resolution model that explains electroencephalography (EEG) data, with specific interests in Anesthesia. These projects are in collaboration with various laboratories/departments at MIT as well as the Massachusetts General Hospital (MGH) and the Brockton V.A. Medical Center.

Substantial progress was made in the area of developing reduced-order models for the cerebellum and its interactions with the cerebrum and spinal cord. Progress has been made in utilizing these models for interpreting

speed and directional information present in actual cerebellar data. This data was collected by collaborator, Dr. Timothy Ebner, from University of Minnesota.

In a parallel effort concerning modeling EEG data, Professors Dahleh and Massaquoi have developed a basic circuit that constitutes the building block of the brain. The circuit describes local and global interconnections between the different layers, and has been successful in simulating several important states of the brain. This development is quite unique and they suspect several interesting fundamental models to emerge. The work is done in collaboration with Professor Dahleh's student, Fadi Karame, Professor Steve Massaquoi, and Dr. Emery Brown (MGH). The objective of this research is to utilize such a model to classify different sleep stages while applying Anesthesia.

Algorithms
This project focuses on analytical and computational methods for solving broad classes of optimization problems arising in engineering and operations research, as well as for applications in communication networks, control theory, power systems, computer-aided manufacturing, and other areas. Currently, in addition to traditional subjects in nonlinear and dynamic programming, there is an emphasis on the solution of large-scale problems involving network flows, as well as in the application of decomposition methods. Professors Dimitri P. Bertsekas and John N. Tsitsiklis and their students perform this work.

Neurodynamic Programming
Problems of sequential decision-making under uncertainty are all pervasive; for example, they arise in the contexts of communication networks, manufacturing systems, logistics, and in the control of nonlinear dynamical systems. In theory, such problems can be addressed using dynamic programming techniques; in practice, however, only problems with a moderately sized state space can be handled. This research effort deals with the application of neural networks and other approximation and interpolation methodologies to overcome the curse of dimensionality of real-world stochastic control problems. The objectives driving this research are twofold. First, to develop the theoretical foundations and improve the understanding of such methods, using a combination of tools from approximation theory, dynamic programming, and stochastic algorithms. Second, to use these methods for solving some large-scale problems of practical interest. Application areas being currently investigated include problems in logistics (resource scheduling and assignment), finance (pricing of high-dimensional derivative instruments, dynamic portfolio management in the presence of risk constraints), supply chain management, and communications (dynamic channel allocation). Professors Dimitri P. Bertsekas and John N. Tsitsiklis and their students perform this work.

Perceptual Systems
Professor Sanjoy Mitter, Dr. Stefano Casadei and their collaborators have been working on various aspects of perception and recognition. Perception and recognition consist in recovering useful information about the environment from sensed data and prior knowledge about the real world and the sensors. Artificial systems designed to carry out this task are much inferior to biological systems, largely due to the size and intricacy of the knowledge required to carry out reliable inference in unrestricted and uncertain domains. For instance, in visual perception, several factors contribute to render the problem difficult: clutter, occlusion, and variability of the objects in the scene. The basic engineering principle of decomposing a complex task into simpler and independent tasks is difficult to apply to perception and recognition due to the extremely complicated and yet unknown pattern of interdependency among the many "acts of perception" involved. For instance the recognition of an occluded chair in a cluttered office environment is highly dependent on the interpretation of its subparts, the other objects near to it and the overall scene of which it is part. What are the components, which are involved in perception and recognition? What architecture should these components be organized into? How does one minimize the interdependence of these components? How should uncertainty be represented? How does one acquire and represent the knowledge about the real world and the sensors? Several projects are being undertaken to find answers to these questions.

- Work in character recognition initiated several years ago is currently being extended to handwriting recognition and signature verification.
- A hierarchical approach to contour estimation is being developed by adding more general models of object contours to the hierarchy. The current edge model being worked on includes illusory contours and curve singularities (corners and junctions) but is limited to convex closed contours.
- Non-conventional probabilistic approaches, such as De Finetti's theory of probability, are being explored to represent uncertainty without resorting to the introduction of artificial priors. In this context, the relationship between set-based models of uncertainty and the probabilistic approach are being studied.
- A new computational theory for the recognition of occluded deformable templates in a cluttered scene has led to efficient algorithms with guaranteed performance in terms of localization errors and time complexity. Currently, this approach has been applied to features consisting of points in the plane and to affine deformations. Future work will seek to generalize these assumptions.
- Early recognition of moving ground targets from an approaching platform is an important task for the military. To enhance the performance of existing systems, it is necessary to combine information from multiple frames, which contain the target at different resolutions. This project is still at an early stage and initial efforts have focused on the incorporation of continuity and smoothness constraints of the relative motion of the target with respect to the camera by means of a geodesic approach.

Language Modeling
During the year 2000–2001, Professor Berwick organized a new research group of professors, graduate students, and undergraduates, to probe the computational properties of Chomsky's "minimalist framework" for language. He developed a novel, stochastic-based model for learning via parameter setting, which has been applied to both speech (learning stress patterns) and syntax learning. Along with his research group, he developed the first computer implementation of Professor Ken Hale and Jay Keyser's model of the lexicon (dictionary), and has shown how to account for 75 percent of the different word order variations in language via this means. Research papers on these topics were presented at the major conferences in Artificial Intelligence and computational linguistics, leading the publication by Kluwer Academic of a book on these topics due out in November, edited by Professor Berwick. In addition, Professor Berwick submitted a patent on a novel algorithm to assemble genes from on-line databases of gene sequence fragments, without resorting to biological methods.

Electric Power Systems
Dr Marija Ilic, together with her graduate students, post doctoral associates and international visitors, continues to work on new concepts for planning and operating electric power systems under restructuring. As it is well known from the recent California energy crisis, competitive electric power industry is not evolving as hoped. Prices are high and changeable, supply is sometimes inadequate and there are no true incentives in place for most effective technology penetration. The research group led by Dr. Ilic has performed a series of studies that should help these issues. The entire January–March 2001 MIT E-Lab Newsletter covers the contributions of her group in this area, and the relevance for the industry. More information about this research can be found online at http://web.mit.edu/energylab/www/e-lab/jan-mar01/jan-mar01.html.

It is becoming increasingly clear that the hardest questions as the power industry transforms itself concern complex system interactions, in which technical, economic and regulatory signals interact under various uncertainties and at non-uniform rates. At present, this group is concentrating its efforts on engineering design of energy markets, which recognizes these complex interactions.

More generally, graduate level courses offered by Dr. Ilic as well as the overall research direction, recognize the need for modeling, analysis and design which begin to relate engineering processes to the economic and regulatory processes. As an example, Dr Ilic just co-authored a book with her former doctoral student Dr Petter Skantze, entitled *A Fundamental Approach to Valuation, Hedging and Speculation in Competitive Electricity Market.* The book is published by Kluwer Academic Publishers, to appear in August 2001. The authors reevaluate a number of key premises underlying modern finance theory, including the arbitrage pricing theory in markets for near non-storable commodities, such as electricity.

CONTROL

Multivariable And Robust Control
The systematic design of multiple-input, multiple-output systems, using a unified time-domain and frequency-domain framework to meet accurate performance in the presence of plant and input uncertainty is an extremely active research area in the Laboratory. Various theoretical and applied studies are being carried out by Professors Munther A. Dahleh, Gunter Stein, Steve Massaquoi and their students. Theoretical research deals with issues of robustness, aggregation, and adaptive control. The aim of the research is to derive a computer-aided design environment for the design of control systems, which can address general performance objectives for various classes of uncertainty. Furthermore, new results on the robustness of nonlinear feedback systems, using feedback linearization, have been obtained for unstructured uncertainty model errors. Recent application-oriented studies include the control of large space structures, helicopters, submarine control systems, issues of integrated flight control, control of chemical processes and distillation columns, automotive control systems, and the modeling and analysis of biological control systems.

New areas of application of robust control theory are now emerging at LIDS, including the real-time, agile guidance of single and multiple Unmanned Aerial Vehicles (UAV) as well as vehicle anticollision problems arising in Air Traffic Control. Some of these concepts are implemented and tested on small helicopter systems. Professors Eric Feron and Steve Massaquoi are beginning a collaboration regarding the brain's internal representation of external world dynamics.

Feedback Control Using Approximate Dynamic Programming
Feedback controllers for nonlinear systems are often driven by potential (Lyapunov) functions, whereby the controller at each step steers the system in a direction of decrease of the potential function. The optimal cost-to-go function that results from dynamic programming formulations of control problems is a suitable such Lyapunov function, except that it may be difficult to compute. This research investigates whether recent approximate dynamic programming methods, that rely extensively on simulation and neural network training, can lead to a viable methodology for designing Lyapunov functions and controllers for nonlinear feedback systems. This research is carried out by Professors Munther A. Dahleh and John N. Tsitsiklis, and their students.

Identification And Adaptive Control
Determining the fundamental limitations and capabilities of identification and adaptive control is an active area of research, carried out by Professors Munther A. Dahleh, John N. Tsitsiklis, and their students. This research program

draws upon areas such as information-based complexity theory and computational learning theory, as well as upon the theory of robust control. One aim of this research is to develop a theory that combines both system identification and robust control within the same framework, in which a controller that meets given performance specifications can be designed based on finite noisy data. Issues studied include the representation of uncertainty in both noise and model, design of experiments, sample and computational complexity, as well as implementation of optimal algorithms.

Computational Complexity
Problems in systems and control theory are of varying degrees of difficulty, ranging from polynomial-time solvable to undecidable. Professor Tsitsiklis and coworkers have been using tools from theoretical computer science (theory of computation) to characterize the intrinsic difficulty of problems in stochastic optimal control, and various stability problems for hybrid systems, saturated linear systems, and linear time-varying systems.

Control In Presence Of Communications Constraints
Professor Sanjoy Mitter in collaboration with Professor Vivek Borkar (Tata Institute of Fundamental Research, India), Dr. Nicola Elia and several graduate students have been working on fundamental issues of control in the presence of communication constraints. The goal of this research is to understand the interaction between information and control in the presence of uncertainty. Development of Real-time Information Theory forms an essential part of this research topic. The recent completed theses of Drs. Anant Sahai and Sekhar Tatikonda demonstrate significant progress in this important subject.

Interference on Graphs, Coding and Statistical Mechanics
Recent research on turbo coding, decoding of low-density parity check codes and statistical mechanisms of disordered systems has shown that there are deep connections between those subjects. Professor Sanjoy Mitter in collaboration with Dr. Nigel Newton has been conducting research on various aspects of these problems.

Unmanned Air Vehicles
Professors Dahleh and Feron with their students, in collaboration with Draper Laboratories have been working on developing control architectures for unmanned vehicles. They have derived an architecture for the autonomous controller that enables the vehicle to perform agile maneuvers. The basis for this architecture is the derivation of a "Robust Hybrid Automaton". This automaton describes a rich set of controlled trajectories that can be attained by the vehicle as well as the control necessary to transition between these trajectories. The robustness analysis of this dynamical description gives rise to a new and exciting class of robustness analysis problems that has not been looked at in the literature. They have developed a complete simulation/animation environment and their software (based on the above architecture) is now completely integrated on board Draper's small vehicle project (expected to fly sometime next year). They are also building a small helicopter. A recent development in this problem is deriving efficient algorithms for performing real-time motion planning (contrasted from path planning where the vehicle dynamics are not taken into account) in a cluttered environment. These algorithms are based on randomization techniques performed on the manifold on which the dynamics evolve. Student, Emilio Frazzoli presented these results at the control and decision conference in December 2000, and the response was extremely positive. This research entails the development of a hierarchical control system that replaces the human pilot in order to perform agile maneuvers.

Professor John Deyst, with sponsorship from the Draper Laboratory, LIDS researchers and students are developing new guidance and control methods for operation of intelligent unmanned air vehicles (UAVs). This work addresses the coordinated action of groups of UAVs that operate cooperatively to accomplish complex tasks. Such coordinated action is required to accomplish tasks that are impossible, or would take excessively long periods of time, for a single vehicle to complete. Significant issues being addressed are the safe and effective flight of UAVs near each other, including rendezvous and docking of one vehicle with another. This capability is of particular significance for resupply of one vehicle by another, so as to allow sustained operation near some desired location, which might be some distance from a user. Coordinated flight is also essential for integrating various kinds of information sensed by many vehicles simultaneously. The operational needs of this class of systems pose particularly stringent requirements on various aspects of vehicle guidance and control.

HIGHLIGHTS
Speakers in the LIDS Colloquium and Seminar Series included: Dr. Thomas Kailath, Stanford University; Dr. Robert Kosut, Vice President, Systems and Control Division, SC Solutions; Dr. David Tse, University of California at Berkeley; Dr. Vijay Balasubramanian, University of Pensylvania; Dr. Michel Geomans, MIT; Dr. Muriel Medard, MIT; Dr. Chuanyi Ji, Rensselaer Polytechnic Institute; Dr. Aleksandar Kavcic, Harvard University; Dr. Thomas Marzetta, Bell Laboratories, Lucent Technologies; Dr. Mustafa Khammash, Iowa State University; Dr. Stephan ten Brink, Bell Laboratories, Lucent Technologies; Dr. Lotfi Zadeh, UC Berkeley; Dr. Daniel Liberzon, University of Illinois at Urbana-Champaign; Dr. Seth Lloyd, MIT; Dr. Andrea Goldsmith, Stanford University; Dr. Nancy Lynch, MIT; Dr. Adam Arkin, E.O. Lawrence Berkeley National Laboratory, UC Berkeley; Dr. Francesco Bullo, University of Illinois at Urbana-Champaign; Dr. James C. Anderson, Lincoln Laboratory, MIT; Dr. Mor Harchol-Balter, Carnegie Mellon.

Visitors to the Laboratory for Information and Decision Systems included: Dr. Nigel Newton, Essex University, Colchester, England; Professor Vevek Borkar, Tata Institute of Technology, India; Professor Manolis Christodoulou, Technical University of Crete, Greece; Professor V. J. Chandra, University of Pennsylvania; Professor Chuanyi Ji, Rensselaer Polytechnic Institute, Troy, NY; Dr. Ulf Jonsson, Royal Institute of Technology, Stockholm, Sweden; Dr. Franchesco Morandin, Scuola Normale Superiore, Italy; and Dr. George Moustakides, University of Patros, Greece.

Professor Dimitri Bertsekas received the 2001 American Automatic Control Council (AACC) John R. Ragazzini Education Award and the 2000 Greek National Award for Operations Research. He was also elected to the United States National Academy of Engineering.

Professor Berwick was awarded a Fellowship as a Visiting Professor to the Princeton Institute for Advanced Studies.

Professor David Forney was inducted into the Mass Telecom Hall of Fame.

Professor Sanjoy Mitter was the recipient of the IEEE Control Systems Award, Plenary speaker at the Conference on Optimal Control and Partial Differential Equations, and Visiting Professor at the Institute for Information Theory and Digital Communications, ETH, Zurich.

Vahid Tarokh was awarded the Alan T. Waterman Prize from the National Science Foundation.

More information about the Laboratory for Information and Decision Systems can be found online at http://justice.mit.edu/.

Vincent W. S. Chan

LABORATORY FOR MANUFACTURING AND PRODUCTIVITY

The Laboratory for Manufacturing and Productivity (LMP) is an interdepartmental laboratory in the School of Engineering with three major goals:

- The development of the fundamental principles of manufacturing systems, processes, and machines;
- The application of those principles to manufacturing enterprises; and
- The education of engineering leaders.

With 11 faculty and senior research staff and 70 graduate students, the laboratory conducts research in the areas of design, analysis, and control of manufacturing processes and systems.

This research is conducted through industrial consortia, sponsored research projects, and government grants. LMP's major areas of interest include: Production System Design, Precision Engineering, Three Dimensional Printing (3DP), Rapid Autonomous machining, Reconfigurable Tooling, Droplet-Based Manufacturing, Automatic Identification, Continuous Casting Monitoring, Machine Elements and Systems, Tribology, Microcellular Plastics, and Composites Manufacturing. In addition, LMP works closely with the Materials Processing Center, the Leaders for Manufacturing Program, and the Lean Aerospace Initiative. Many of our research projects are also with individual companies. In total, the laboratory works with about 50 different companies worldwide. Our government support, which is often coordinated with industrial support, comes from a variety of agencies: Department of Defense (DOD), National Science Foundation (NSF), National Aeronautics and Space Administration (NASA) and Department of Energy (DOE).

The Laboratory for Manufacturing and Productivity enjoyed an excellent year in 2000–2001 with a research volume of $4M. A few projects contributed disproportionately to this volume. These included the work of Professor Ely Sachs (3D Printing), Professor David Cochran (Production Systems Design), and Professor David Trumper (Precision Engineering).

RESEARCH AND EDUCATION HIGHLIGHTS, AWARDS

In the past year, we have seen significant new and/or continuing research programs being funded and several new educational initiatives were started. In addition, our faculty and staff continue to be honored with awards and recognition by their colleagues.

Professor Jung-Hoon Chun, who is the Co-Director of the Manufacturing Institute, is also actively involved in the Singapore-MIT Alliance (SMA). Last year Professor Chun started two new courses for SMA, Manufacturing Physics I, and Business Fundamentals. SMA courses are presented in Singapore from MIT via distance learning. Professor Chun has also started, "The International 70-nm Initiative." This consortium is formed within the broader Advanced Planarization Consortium as part of the Manufacturing Institute. Professor Chun has been actively involved in the recruiting of industrial participation for these two consortia. From previous work for Silicon Valley Group (SVG), one patent has been issued in the area of Photo Resist Coating for Semi-conductor Manufacturing. Next year, Professor Chun will be on sabbatical.

Professor David Cochran's program in Production System Design continues to grow and to expand in new areas. This year, Professor Cochran captured important new funding from leading aerospace companies and the computer industry. This builds on his current very strong links with the automotive industry. In addition, Professor Cochran was promoted to Associate Professor of Mechanical Engineering.

Dr. Stanley B. Gershwin, who is the Associate Director of the LMP, was recently honored by the Third International Aegean workshop on Analysis and Modeling for Manufacturing Systems, receiving the citation, "for his pioneering leadership of, and outstanding contributions to the field of Manufacturing Systems Engineering." Dr. Gershwin has continued his research on Wafer Fab Operations Modeling and Analysis and other important systems modeling areas and is currently actively involved in the Singapore-MIT Alliance as a SMA Associate.

Professor David Hardt has taken a principal leadership role as liaison faculty in manufacturing to the SMA. As part of his responsibilities, he has developed a MEng in Manufacturing degree program for Singapore. This highly integrated set of courses that cover topics from processing, equipment, automation, process control, systems and

product design as well as basic business issues was introduced to Singapore by MIT faculty last summer. Professor Hardt has also expanded his research into new areas including Space Interferometry.

Professor Samir Nayfeh is developing significant new research in precision machine design, mechanical power transmission, machine dynamics, and control. He is initiating an effort to develop the automated factory of the future following the open-source model that has been so successful in the complex software that holds the Internet together. And, this year, Professor Nayfeh welcomed a new daughter to his family.

Professor Ely Sachs, whose 3D Printing and related activities continue to lead in the laboratory, has major projects to further apply and develop the 3D Printing process. These include: Distributed Design and Fabrication of Metal Parts by 3DP, 3DP for Automotive Tooling for Casting, 3DP of Integrated Ceramic Components, Prototyping and Manufacturing of Cutting Tool Inserts by 3DP, and Tooling-Free Manufacturing of Metal Matrix Composites. Professor Sachs will be on sabbatical for the academic year 2001–2002.

Last year Professor Sanjay Sarma, the Cecil and Ida Green Career Development Professor founded the Auto-ID Center with his colleagues, Dr. David Brock and Professor Kai-Yeung Siu. The center's mission is to create an intelligent infrastructure to connect physical objects to the Internet and to each other. This consortium continues to grow with applications to inventory control, material tracking and reordering and material and product recycling. The center now has 30 sponsors and has started a sister center in the University of Cambridge, England. Professor Sarma has also continued his work in Computer Aided Design (CAD)/Computer Aided Manufacturing (CAM)/Computer Numerical Control (CNC) and haptics. A new CAD/CAM system developed by his group is now in negotiation for licensing.

Professor Alex Slocum has been active in evolving precision engineering fundamentals for application to biomedical engineering challenges. Specifically he has been using the fact that repeatability is less costly than accuracy to create a fundamental new way to detect breast cancer. He has received current seed funding for this project from Center for Integration of Medicine and Innovative Technology (CIMIT) at Massachusetts General Hospital (MGH). His research work continues to grow in Micro Electro Mechanical Systems (MEMS) with major projects sponsored by Asea Brown Boveri (ABB).

Professor Nam Suh stepped down as Head of the Department of Mechanical Engineering this year and rejoined the Laboratory for Manufacturing and Productivity. Last year, he was honored by the Royal Institute of Technology, Stockholm, Sweden 2000, with a Doctor H.C. He also received the 2001 Mensforth International Gold Medal of the Institution of Electrical Engineers of the United Kingdom and also the first Hills Millennium International Award of the Institution of Engineering Designers of the United Kingdom in June 2001. He continues to lead the international development of the field of axiomatic design and this year, his new book, *Axiomatic Design: Advances and Applications* by the Oxford University Press, was released.

This year Professor David Trumper was on family leave and sabbatical. His research program has continued in the areas of Precision Motion Control and Systems. He has been awarded two patents in the last year and has filed disclosures in four new concepts during this time. He has also been selected as a recipient of the 3M Innovation Award. Last year, Professor Trumper was honored by the American Society of Mechanical Engineers (ASME) with the Leonardo Da Vinci Award and was also honored by MIT with the Spira Award for Excellence in Teaching.

This last year, Professor Timothy Gutowski served as panel chairman and co-author for an important new publication on *Environmentally Benign Manufacturing* (available at http://itri.loyola.edu/ebm/ebm.pdf). This study was based upon an international assessment of environmentally conscious behavior at leading manufacturing companies in Japan, the Europe and the United States, and was sponsored by the National Science Foundation and the Department of Energy. This work led to the development of a new graduate course at MIT entitled Environmentally Benign Manufacturing. Professor Gutowski's research has now expanded into Manufacturing System Design as well as studying the environmental impacts associated with manufacturing. He also continues his research on composite materials.

Timothy G. Gutowski

LEADERS FOR MANUFACTURING

The Leaders for Manufacturing (LFM) Program is a partnership between MIT and over 25 global manufacturing firms to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. This partnership is motivated by our shared belief that excellence in manufacturing is critical to meeting the economic and social needs of individuals, firms, and society, and that the health of companies operating in global markets is essential to society's well-being.

Now, in its 13th year of operation, LFM is a partnership between the School of Engineering, the Sloan School of Management, and leading manufacturers. Launched in 1988 with significant industry funding, the program emphasizes collaboration and knowledge sharing with its partner companies across the entire spectrum of "Big-M" manufacturing enterprise issues. LFM supports students both as fellows in the program (with fully-paid tuition). The largest component of the educational efforts is the Fellows Program, a 24-month dual masters degree (S.M. in engineering and MBA or S.M. in management) experience involving a single integrative research project carried out on site in partner firms.

ACADEMIC PROGRAMS

Forty-eight students in the class of 2001 completed the fellows program and approximately 80 percent have taken positions in manufacturing firms. Each of the 48 graduates completed an internship at a partner company during the summer and fall of 2000. Internships are focused projects of concerns to the partners, accomplished by interns with company support and MIT faculty guidance. Representative projects this past year included modeling design rework in a product development process, integration of the design and manufacture of high-precision cast components, evaluating wastewater treatment technologies, and addressing the complexity of multimedia wireless computing solutions, among others.

Another 49 students (class of 2002) completed their first year of on-campus studies and are starting their six-month internships. Forty-eight new students (class of 2003) were admitted and have begun an intensive summer session. The class of 2003 has an average of 4.8 years of work experience.

Don Rosenfield continues to serve as the Director of LFM Fellows. Co-Directors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger. Steve Eppinger, General Motors LFM Professor of Management at the Sloan School of Management, assumed the LFM-SDM (System Design and Management) Co-Director's position on July 1, 2001 when Steve Graves, who has been an LFM Co-Director for 10 years, was elected Chair of the Faculty. Both began their new position effective July 1, 2001. Steve Eppinger is no stranger to LFM-SDM. His course, Product Design and Development, is a favorite of students in both programs, and he frequently supervises LFM and SDM students for internship and theses projects.

RESEARCH AND KNOWLEDGE TRANSFER PROGRAM

As part of LFM and SDM's commitment to lifelong learning, a new initiative was introduced to encourage LFM and SDM alumni to stay connected with MIT by sharing relevant information. Paul Gallagher, research associate for LFM and SDM, established monthly web casts presented by various LFM and SDM alumni. The content of each webcast, also called e-seminars, provides valuable information on the latest trends, cutting-edge developments and innovative strategies, all of which pertain to manufacturing and/or systems design. The presentations are given in real time, via the Internet and telephone, which allowed participants to follow along visually and audibly as well as ask questions.

Presenters have included Steve Graves discussing his research on supply chain issues, Don Rosenfield on manufacturing strategy, and Sara Beckman, from the Haas School of Business at University of California at Berkley, talking about vertical versus virtual integration.

Due to the positive feedback, the webcasts will continue into the next academic semesters.

OUTREACH

LFM continues its leadership role in the National Coalition of Manufacturing Leadership (NCML), a partnership of 15 universities with joint management and engineering manufacturing programs. In conjunction with the NCML, MIT, University of Michigan, and Penn State University once again sponsored a recruiting forum, the National Manufacturing Recruiting Forum (NMRF), which was hosted this past year by Penn State University. More than 118 students and 50 companies participated in last year's event, in which LFM makes a significant contribution to

the NMRF by providing a robust, web-based interview scheduling system that increases interview scheduling efficiency. The NCML meets twice a year to share curriculum, research, and program best practices.

PLACEMENT

LFM students, sponsored and non-sponsored, continue to be highly sought once they have completed the program. Partner companies as well as other organizations take a special interest in LFM students as proven by their commitment to speak to the class on various issues during the Pro Seminar session. About 80 percent of each class accept positions within the manufacturing industry while the percentage of students accepting positions within partner companies has remained at about 50 percent. Within the past two years, however, LFM has experienced a slight increase in the number of graduates who have accepted positions in consulting. Ten percent to fifteen percent of students have chosen this field.

More information about the Leaders for Manufacturing Program can be found at http://lfm.mit.edu/.

William C. Hanson

MATERIALS PROCESSING CENTER

This report discusses the FY2001 accomplishments of the Materials Processing Center (MPC) and the Microphotonics Center. The MIT Microphotonics Center was created within the MPC and is currently administered by MPC staff; it will be treated as a separate entity within the context of this report.

The Materials Processing Center is an interdisciplinary center within MIT's School of Engineering. Currently directed by Professor Lionel C. Kimerling (Department of Materials Science and Engineering), the MPC was established in 1980 in response to a recognized national need to improve the materials processing knowledge base and streamline the process of technology transfer within the materials science and engineering field. MPC research covers a broad range of materials and processes.

The mission of the MPC is to provide an environment where students and professionals from industry, government, and academia collaborate on pivotal multidisciplinary issues in materials science in a way that creates new knowledge, produces knowledgeable and capable employees, and promotes the exchange of information in the service of our country and in the context of a global community. In accomplishing its mission, the MPC reaches out to students, faculty, and industry.

The mission of the MIT Microphotonics Center is building interdisciplinary, intramural research teams focused on advancing basic science and emerging technology in areas relevant to the creation of new materials, structures, and architectures to enable the evolution of photnics from single discrete devices to strongly interacting, integrated photonic systems. The research of the center is organized as a highly coupled set of activities that allow for individually driven discovery within a context of goal-oriented research. The basic programmatic units are theory and design, materials and processing, and characterization and performance. Students are expected to master a vertically integrated set of skills that extends to the fabrication of functional prototypes.

MATERIALS PROCESSING CENTER

Because of the interdisciplinary nature of the field of materials processing, faculty and research staff affiliated with the Materials Processing Center come from a wide range of fields. MPC-affiliated faculty and research staff number 205 and hail from the Departments of Aeronautical and Astronautical Engineering, Architecture, Biology, Chemical Engineering (ChemE), Chemistry, Electrical Engineering and Computer Science (EECS), Materials Science and Engineering (DMSE), Mechanical Engineering (MechE), Nuclear Engineering, Ocean Engineering, and Physics. Faculty and researchers from the Francis Bitter Magnet Lab and Lincoln Lab also participate in MPC programs. For MPC affiliates, the MPC serves as a bridge, via its Industry Collegium, to bring research results to industry's attention.

The MPC Industry Collegium is made up of over 40 domestic and international companies in a range of industries, from traditional steelmaking to biomaterials. For member companies, the Collegium serves as a window on cutting-edge materials research and development at MIT. Researchers at MIT have the common goal of wanting their leading-edge research to relevant and have impact. The MPC Collegium helps to enable that realization of groundbreaking science into market-changing products, providing a pathway for technology transfer between the university and industry. Part of our strategy is to leverage core federal research funding into expanded industrial-academic collaborations.

MPC research volume holds at $7.4M. At the same time, the research volume associated with the Microphotonics Center, was $4M for 20+ faculty (see below). This represents an overall research volume increase of 50 percent for the combined Materials Processing and Microphotonics Centers. The MPC staff during FY 2000–2001 numbered five (including director Professor Lionel Kimerling), and the MPC has recently added an office assistant, bringing total staffing to six.

During much of FY2001, the Materials Processing Center focused on the development and expansion of the Microphotonics Center. The latter center shares staff, office space, and resources with the Materials Processing Center, and is operating as an administrative sub-center of the MPC. Please see below for a description of the activities of the Microphotonics Center during FY2001.

AWARDS

The staff of the Materials Processing Center received recognition from the School of Engineering, receiving the first "Infinite Mile Award for Team Excellence" during the past year. Center staff Dr. George Kenney (Associate Director), Ms. Frances Page (Assistant to the Director), Mr. Jonathan Bartels (Administrative Officer), and Dr. Jennifer Pell (Publications Editor/Webmaster) were recognized for their efforts in launching the Microphotonics Center while maintaining the high standards of the Materials Processing Center.

MPC-affiliated faculty and research staff have over FY2001 been recognized with awards too many to be listed here. Please see the FY2001 issues of our newsletter, the Industry Collegium Report, for details. The report is available online via a link from our home page (see below).

EDUCATION ACTIVITIES

One pillar of the Materials Processing Center is the education of the next generation of materials processing research scientists, engineers, and leaders. To this end, the MPC initiates programs to enhance the intellectual vitality of the materials processing community at MIT. We measure the value of these programs by the breadth of the materials science they address, by the new and creative collaborations among researchers they catalyze, and by the degree of attention to the multidisciplinary—but at the same time fundamental—nature of materials processing they generate.

Materials Unlimited Seminar Series

Now in its third year, the Materials Unlimited Seminar Series highlights the research of senior graduate students identified by faculty members as being among the best in MIT materials-related research. Seminars include a half-hour talk by the featured graduate student, followed by a half-hour panel discussion. Panelists are drawn from MIT and other university faculty, as well as from companies appropriate to the topic. Seminars are well-attended by a diverse audience of faculty, postdocs, graduate students, and undergraduates.

FY2001 featured three talks. One by Andy Luan (DMSE) was on "Ge Photodetectors for Si Microphotonics," and had Professors Lionel Kimerling and Clif Fonstad (MIT), as well as Gary Bjorklund (Nanovation Technologies) as panelists. Jinsang Kim (DMSE/Chemistry) spoke about "Defining Intrinsic Optical Properties of Conjugated Polymers," with Professors Timothy Swager, Michael Rubner (MIT), and Daniel Sandman (University of Massachusetts-Lowell), as well as Dr. Larry Hancock (Nomadics, Inc.) as the panelists. Edward Ahn (ChemE) talked about "Nanostructured Biomaterials for Orthopaedic Applications," with Professors Jackie Ying and Lorna Gibson (MIT) and Professor Myron Spector (Harvard Medical School) as panelists.

Materials Day

The Fifth Annual Materials Day celebration was held in October 2000 under the title and theme "Growing Opportunities: Where Materials and Biology Converge." Approximately 200 from MIT, local universities, and industry registered to attend. Co-Chaired by Professors Douglas Lauffenburger (ChemE/Division of Bioengineering and Environmental Health [BEH]) and Robert Cohen (ChemE), the program included talks by Professors Paul Matsudaira (Biology/BEH, "Molecular Springs and Ratchets: Powerful Engines that Drive Cellular Movements"), Anne Mayes (DMSE, "Materials for the Control of Cell Behavior"), Roger Kamm (MechE and BEH, "Mechanical Issues in Biomolecular Materials and Materials/Cell Interactions"), Barbara Imperiali (Chemistry, "Biomolecular Design and Function"), and Linda Griffith (ChemE, "Microfabricated Structures for 3D Tissue Engineering). The late afternoon program featured a poster session open to graduate, undergraduate, and postdoctoral researchers in materials science. Sixty-nine presenters defended 43 posters, six of which received a $500 prize for "best poster" as judged by a panel of faculty and industry judges. The winners were Edward Ahn (ChemE), Wendy Katstra and Dr. William Rowe (DMSE), Davide Marini (Biology), Dr. Dierdre Pearce (Chemistry), Milos Popovic (EECS), and Michael Shin (ChemE). The Keynote Speaker for the evening program was Dr. James Meyer of DuPont Central R&D, on the topic "The Convergence of Biology and Materials: Exploiting the Opportunities."

Summer Research Internship Program

The MPC and Center for Materials Science and Engineering (CMSE) co-sponsor the MPC-CMSE Summer Research Internship Program. This ten-week program brings outstanding juniors and seniors in science or engineering majors from academic institutions around the United States to MIT to work in the laboratories of participating faculty and hear weekly talks on subjects of relevance to budding materials researchers. Summer 2000 saw ten students from the Universities of Southern Mississippi, Illinois at Urbana-Champaign, Washington, Missouri-Rolla, and Maryland; Iowa State, Utah State; and Case Western Reserve, Yale, and Washington Universities. These students worked with faculty from ChemE, MechE, DMSE, the Active Materials and Structures Lab, the Magnet Lab, and the Technology Lab for Advanced Composites (TELAC) on a wide variety of projects.

During FY2001 the decision was made to expand the Summer Research Internship Program, and the summer 2001 session, just begun at the time of this report, has brought 17 students to MIT.

Other

The MPC also supports the MIT Solar Car Team with a $5K grant. See http://u6.mit.edu/activities/solar-cars/ for information about this student organization.

OUTREACH

The second pillar of the Materials Processing Center is its outreach to new (either to MIT and to the MPC) faculty and researchers, as well as to the global materials industry. The center is proactive in inviting faculty to participate in center activities, whether through our publications, educational programs, or research sponsorship. Seed funding for young faculty is available.

Industry Collegium

The MPC Industry Collegium maintained its size and full complement of activities while simultaneously increasing the industrial support base of the Microphotonics Center. One new collegium member in particular has sponsored dedicated research projects with two MPC-affiliated faculty, in addition to its standard collegium membership. Collegium membership currently exceeds 40 companies, domestic and international.

Publications
The Microphotonics Center produces two main publications, plus a number of minor brochures and a conference booklet, in pursuit of its outreach goals. Distribution for both of the main publications includes MPC-affiliated MIT faculty and staff (> 200) and members of the MPC Collegium mailing list (> 400). One publication, *Materials Research at MIT*, is a digest of materials research performed at MIT by MPC-affiliated faculty and others during the previous calendar year. It provides a short summary of each project being researched by faculty members, along with a list of their personnel and publications. *Materials Research at MIT 2000* provided the reports of 83 faculty members, a small increase over the two previous years' approximately 75. The 2000 book was also redesigned to improve readability.

The MPC's other major publication is the *Industry Collegium Report*, a thrice-yearly newsletter on the activities of the Materials Processing Center. During 2000, this newsletter was changed in format and tripled its content page-length. It also qualitatively changed its content focus from short articles on events to longer, more in-depth articles on research. One of its articles was reproduced (with some re-writing) in *Tech Talk* and resulted in a number of outside inquiries about the research.

Faculty Outreach
The MPC has added several new faculty members to its affiliated faculty pool: Vladimir Bulovic (EECS), Patrick Doyle (ChemE), and Leonid Levitov, Young Lee, Senthil Todadri (Physics).

RESEARCH
Research volume statistics have been given above. Details on the FY2001 research by MPC-affiliated faculty can be found in our 2001 annual report, *Materials Research at MIT 2001*, available online via a link from our home page.

MICROPHOTONICS CENTER

The MIT Microphotonics Center was announced in the fall of 1998 by the Materials Processing Center and commenced activity by the pooling of intellect and ongoing research funds (now ~$18M for 2000) of a group of faculty. The participating faculty had been working in loose collaboration across a variety of subjects ranging from components for telecommunications and computing to optical coatings. The driving forces for the organization were the amplification of the synergy that had been realized through the multidisciplinary collaborations, and attraction of industrial support to MIT research. The center is currently administered by the staff of the Materials Processing Center. Center activities are highly interdisciplinary. Microphotonics Center-affiliated faculty currently number 21 and represent seven departments across three Schools: MechE, EECS, ChemE, DMSE, Chemistry, Physics, and the Sloan School. During FY2001, we have added Professors Vladimir Bulovic (EECS), Yoel Fink (DMSE), and George Barbastathis, and Sang-Gook Kim (both of MechE) to the pool of faculty affiliated under the Microphotonics Center umbrella.

One of the major Microphotonics Center activities in the last year, and ongoing into the coming year, has been a diligent effort creating the world's best processing facility for photonic components. The research areas have been designed and programed for theory and design work; layered growth of III-V, Si-based dielectric, and organic components; fabrication of prototype passive dielectric-based components (e.g. waveguides) and active compound semiconductor-based components (e.g. lasers, detectors); an area for research on and prototype construction of displays based on novel organic materials; a photonic component packaging facility; and full characterization facilities. Industry partners are supporting the equipment infrastructure, and we are actively supporting the Capital Campaign in a major effort to secure support for the dedicated space. In the near term, we are constructing temporary facilities in distributed "migration" space, so that we can maintain research leadership even as we continue to look forward to a consolidated facility and the synergies that it will bring to MIT Microphotonics Center research.

EDUCATION
The Microphotonics Center is dedicated to providing a community of researchers and engineers educated in technical and business-strategy issues of this emerging field. The Center sponsors a weekly seminar series, which is attended by an average of 40+ faculty, postdocs, students of all levels, and visitors. Speakers have included MIT and other university faculty, postdocs and senior graduate students, and industrial visitors. For a list of past and future seminar topics and speakers, see our home page at http://mphotonics.mit.edu/ and follow the "seminars" link.

RESEARCH
One particular focal area for Microphotonics Center research is in new materials, structures, and architectures for planar lightwave circuits (PLC's). The goal is fully integrated photonic functionality for these tiny, low-cost units, thereby enabling their deployment in metropolitan area (MAN) and fiber-to-the-home (FTTH) applications. Our areas of emphasis include dense wavelength-division multiplexing (DWDM, a way of increasing signal-capacity), optical signal conditioning, and on-chip optical clock distribution and I/O for microprocessors. Our research has set world records for performance at 1.3- to 1.55-micron wavelengths (the standard for optical communications). We have achieved the smallest waveguide bends (1 micron bend radius); the smallest ring resonators (1 micron radius); the first coupled quadruple micro-ring resonator structures for high-definition channels; the smallest multimode interferometer (MMI) beam splitters (1x8 in 7.5-by-15 microns); the smallest in-line add/drop filter (0.055 cubic micron volume); the smallest multichannel add/drop and multiplex/de-multiplex (MUX/DEMUX) circuits; the

worldwide best performing waveguide-integrated Ge photodetectors 1.3- to 1.55 micron wavelengths; the first erbium-doped silicon light-emitting diode (LED); and the first terahertz (THz) oscillator based on an erbium-doped microcavity. Beyond these, we have engineered a range of components based on photonic crystal concepts to enhance the extraction efficiency of light sources and route signals in high-level cross-connect circuits.

See the 2001 research digest, *Bringing New Technology to Light*, for information on Microphotonics Center-affiliated research projects and for details on the progress of the groundbreaking research cited above. This book is available online via a link from the Microphotonics Center home page. Microphotonics Center research sponsored by Nanovation Technologies, Inc., alone generated nine new IP filings. In FY2001 Microphotonics Center research volume was $4M for 20+ faculty members, and these faculty members published some 230 papers in the microphotonics area.

In addition, the Microphotonics Center Industry Consortium (see below) began its key initiative, an Information Technology Roadmap Project, in the Fall of 2000. This ongoing study will give a 10-year view down the rapidly changing microphotonics technology highway. Consortium members will use the study findings in optical network architecture, component design and manufacturing, market analysis, technical supply chain analysis, and geographic analysis to focus their R&D and business strategies. The Information Technology Roadmap Project is chaired by Professors Charles Fine (Sloan School) and Rajeev Ram (EECS). It provides background information and updates every fifth week of the weekly Microphotonics Center seminars. The first formal report of the Roadmap Study Committee will be distributed to Microphotonics Center Consortium member companies in early fall 2001.

OUTREACH

As with the MPC, outreach, both to researchers within MIT and to industry, is the *sine qua non* of the Microphotonics Center.

Industry Consortium

The Microphotonics Center has established an industry consortium to create a proactive forum where researchers from MIT and from industry can work as partners in defining and pursuing critical microphotonics R&D. Like the MPC's industry collegium, the Microphotonics industry consortium provides a bridge between MIT technology and potential commercialization. The MIT Microphotonics Center Consortium Founding Member companies share royalty-free licensing to all research funded by the Consortium and participate in the Information Technology Research Project. The Microphotonics Center has obtained commitments from eight companies to join the consortium, and has ongoing talks with others, whose businesses represent the entire industry supply chain from service providers to basic materials suppliers. The consortium will hold a formal kickoff meeting in fall 2001.

Major Agreements for Fiscal Year 2001

In April 2001, MIT and Walsin Lihwa Corporation, the leading Taiwanese DRAM (Dynamic Random Access Memory) manufacturer and cable/wire supplier, signed a major agreement to collaborate on research via the Microphotonics Center. The five-year master sponsored research agreement provides a minimum $3M in the first year to research designs and processes for laser diodes and lightwave components for compact and low-cost DWDM systems. The research alliance with Walsin Lihwa is expected to evolve to a five-year partnership during the coming year.

Program Expansion

During the past year the Microphotonics Center held 15 major research briefings for individual domestic and international corporations. New industry partnerships have resulted in a major equipment donation from Applied Materials and Memoranda of Understanding with two other companies to form Research Alliance relationships with the MIT Microphotonics Center.

Publications

The Microphotonics Center launched *Bringing New Technology to Light*, an annual report of relevant research by Microphotonics Center-affiliated faculty. This volume is similar to the Materials Processing Center's annual research digest, described above.

OUTLOOK

The Materials Processing Center and the Microphotonics Center continue to serve as a valuable bridge between MIT materials and microphotonics research, respectively, and industry. Our goals for the future include the expansion of this role as well as a reaffirmation of our role in educating the local community in materials and microphotonics through our seminar series and through the MPC-CMSE Summer Research Internship Program. We expect to expand and develop our web presence in the coming year to provide more educational content for the general public on the relevance of the research conducted within our areas.

For both organizations, our outreach efforts both within MIT—to involve more faculty, and particularly young faculty—and outside MIT—to continue to develop company ties to the MPC Industry Collegium and the Microphotonics Center Industry Consortium, as well as through one-on-one research sponsorship or alliance programs—will continue apace. Our publications, including our web site, remain a key part of that effort. The *Microphotonics Center Annual Report* will be expanded into a research digest that will report on microphotonics-

related research for both center-affiliated and non-affiliated faculty who wish to be represented in this report. We will also launch, during 2001, a Microphotonics Center newsletter similar in format to the MPC newsletter.

More information about the Materials Processing Center may be found online at http://web.mit.edu/mpc/www/. More information about the Microphotonics Center may be found at http://mphotonics.mit.edu/.

Lionel C. Kimerling

MICROSYSTEMS TECHNOLOGY LABORATORIES

The Microsystems Technology Laboratories (MTL) conduct research and education with an intellectual core of Semiconductor Industry Process and Device Technology, and Integrated Circuits and Systems Design. MTL also leverages its infrastructure to foster new initiatives at the Institute and to support the general microfabrication needs of MIT.

The MTL carries out graduate and undergraduate research activities in circuits and systems that are built using microsystems technology for applications, such as wireless sensing networks and intelligent vision systems. Additionally, researchers are investigating the fabrication and study of small (i.e., micrometer to nanometer) structures and their use for the implementation of interesting integrated devices from nanometer-scale electronic devices to optical switches to displays to biosensors to microturbine engines. The MTL facilities include laboratory space for electronics test and assembly, computation and communication, and microfabrication. The MTL microfabrication facilities include three clean rooms: the state-of-the-art class-10 Integrated Circuits Laboratory (ICL), the flexible process environment Technology Research Laboratory (TRL), and the Exploratory Materials Laboratory (EML). In AY2001, the MTL fabrication facilities were utilized by approximately 350 students and staff. The laboratory manages a contract research volume of approximately $7M per year. In addition, approximately $25M of contract research (managed in other departments/labs/centers) supporting 40 faculty and senior research staff utilizes the MTL facilities as an integral part of their research. The fabrication and computation facilities of the MTL are maintained and operated by a full time technical staff of 21 technicians and engineers.

Beyond the research programs, the MTL support several educational initiatives that leverage the research infrastructure of the labs. Chief amongst these is the undergraduate microfabrication laboratory, a lecture/laboratory course in which 120 students/year are afforded the opportunity to microfabricate an electronic device in the state-of-the-art MTL facilities. Additionally, we offer a project laboratory for team-based design of microfabricated structures. The Technology Demonstration Laboratory, developed by Professor Sodini, is housed in MTL and provides Electrical Engineering and Computer Science (EECS) MEng students the chance to work on thesis topics with a technology integration and demonstration focus. Lastly, via the I-Campus Initiative, Professor del Alamo is developing a series of web-based laboratory tools that permit testing of microfabricated structures.

MTL maintains a strong and vibrant interaction with industries that value not only the research output, but also the students that are educated in state-of-the-art microsystems technology. The MTL facilities are supported in part by industry through the MIT Microsystems Industrial Group (MIG), whose current members include: Advanced Micro Devices (AMD), Analog Devices, Applied Materials, Compaq, IBM, Intel Corporation, Agere, Motorola, Inc. Novellus Systems, Texas Instruments, and Taiwan Semiconductor Manufacturing Corporation (TSMC), as well as members of the Microsystems Affiliates Program whose members are Kokusai/BTI Corporation and Sony Corporation. Three industry-funded centers are also housed in the MTL: the Center for Integrated Circuits and Systems (CICS), and the Intelligent Transportation Research Center (ITRC), and the newly-formed MicroElectroMechanical Systems (MEMS) @ MIT.

HIGHLIGHTS

We have nearly completed the $12M renovation of the cleanroom facilities and equipment to upgrade to 6" wafer capability. This upgrade will be completed by September.

A new epitaxial growth laboratory was established by Professor Judy Hoyt. The laboratory features a state-of-the-art Applied Materials Epi-Centura system, which was obtained through a combination of a National Science Foundation Major Research Instrumentation Program (NSF MRI) award and a significant donation from Applied Materials. The cost of this laboratory, including the equipment is in excess of $2.5M. This laboratory will enable research into advanced silicon-based materials and devices. We anticipate the laboratory to be operational within the next few months.

Three significant research contracts were awarded this year by the Microelectronics Advanced Research Corporation (MARCO) to investigators in MTL. These three multi-university collaborations focus on research in Interconnects, Materials, Circuits and Devices, and Circuits, Systems and Software. MARCO was established by an industrial consortium to fund long range research of interest to the semiconductor industry. These contracts will represent a significant growth of the research activity in MTL.

A thorough evaluation of the MTL cleanroom operations was conducted by a student/faculty/staff committee chaired by Professor Jesus del Alamo (The Class 1 Committee). The goal of the committee was to make recommendations for how to improve the operations. The committee has concluded its work and the report has been carefully evaluated. We have begun to implement changes based upon the committee's report and will continue to implement the recommendations.

Considerable effort was expended in the past year to address overlap in microfabrication needs between MTL and the recently formed Microphotonics Center. Many opportunities exist for sharing of resources and leveraging existing infrastructure and we will continue to work in cooperation to identify these opportunities.

A new center, MEMS @ MIT, was formed this year. The intent of the center is to generate industrial support for shared microfabrication, design, and test infrastructure that benefit the 20 faculty at MIT that conduct MEMS research using the MTL facilities. The center, which will be managed as a center in MTL, is currently soliciting members. Industrial participation in this center is intended to compliment the industrial engagements which currently exist in MTL (MIG, CICS, and ITRC).

FUTURE PLANS

The MTL research and education initiatives have expanded by approximately 10 fold in the past 15 years without a significant growth in the space allocation to the laboratory. This has created intense pressure on the researchers in the laboratory and has forced us to continuously work to optimize the use of space in the laboratory. It is clear that the primary limitation on growth of the laboratory into logical new research areas is paced by the availability of space to accommodate this growth, and funding to support the shared infrastructure. As part of our strategic planning process, we have identified four primary initiatives. First, we want to maintain a pre-eminent micro/nanofabrication infrastructure for the Institute. Second, we want to foster new initiatives at the Institute that leverage this infrastructure. Third, we want to promote interactions between the circuits/systems community and the micro/nanofabrication community in MTL. Fourth, we want to develop a more diversified funding structure to support the MTL infrastructure. As part of this plan, we have some immediate actions as detailed below.

We will complete the 6" upgrade of the laboratories shortly, after which a complete characterization of these new tools will be conducted.

We will implement the important recommendations of the Class 1 Committee, which primarily require additional industrial revenue for infrastructure, acquisition of space, and hiring of more technical support personnel in key areas. We anticipate a need for approximately $1–$1.5M per year in additional investment in the cleanroom operations. These investments will be made in new personnel, primarily to support equipment repair and training. Additionally, we will look to service contracts on key equipment.

We will begin a concerted effort to recruit new membership in the MIG in support of the Class 1 needs.

We will conclude the launch of the MEMS @ MIT Center by securing an initial roster of member companies. The revenues from the MEMS @ MIT Center will support many things, including the microfabrication infrastructure.

We will continue to explore mechanisms to produce intellectually vibrant links between the two primary research constituents of the lab: the Circuits and Systems design community and the Micro/Nanofabrication community.

More information about the Microsystems Technology Laboratories can be found online at http://www-mtl.mit.edu/.

Martin A. Schmidt

PROGRAM IN POLYMER SCIENCE AND TECHNOLOGY

The Program in Polymer Science and Technology (PPST), founded in 1986, is an interdepartmental program offering graduate education in the interdisciplinary field of polymer science and engineering. Its goals are to provide educational opportunities and to foster a spirit of community and collaboration among the large and wide-spread group of students, faculty, and visitors involved in polymer-related activities at MIT. It consists of a core curriculum, written and oral qualifying procedures for doctoral studies, and continuing education opportunities through seminars, visitors from industry and academia, and research competitions. The program is administered by faculty from the Departments of Materials Science and Engineering, Chemical Engineering, Mechanical Engineering and Chemistry. PPST also serves as a focal point for information and opportunities in polymer-related fields at MIT.

There were 33 students enrolled in PPST in 2000–2001, with home departments in the four disciplines from which PPST draws its faculty. This year the Program graduated four students with Ph.D. degrees and two with M.S. degrees. Seven new PPST students were admitted into the Program from the Departments of Chemical Engineering (2), Chemistry (1), and Materials Science and Engineering (4).

In February 2001, the Directorship of PPST changed hands from Professor Michael F. Rubner to Professor Gregory C. Rutledge, from the Departments of Materials Science and Engineering and Chemical Engineering, respectively. Professor Rubner has provided leadership to the Program since 1996. The main office of PPST also moved from Building 13 (Room 5110) to Building 66 (Room 370).

Two new professors were added to the PPST faculty: Christine Ortiz from the Department of Materials Science and Engineering and Professor Ken Beers from the Department of Chemical Engineering.

The PPST weekly seminar continues to attract an average of 50–80 students, faculty and visitors per seminar. This past year, lectures were presented by leading polymer faculty from a number of US and European universities as well as from faculty and senior students within MIT. Professor Paula Hammond from the Department of Chemical Engineering has continued her important role of organizing the PPST seminar.

More information about the Program in Polymer Science and Technology can be found at http://web.mit.edu/ppst/.

Gregory C. Rutledge

SINGAPORE-MIT ALLIANCE

The Singapore-MIT Alliance (SMA) is a global partnership in graduate education between MIT, the National University of Singapore (NUS), and Nanyang Technological University (NTU). The objectives of the SMA program are threefold:

- To set a new standard for international collaboration in graduate research and education;
- To invigorate engineering education in Singapore; and
- To strengthen MIT through extending its global impact, enhancing its curriculum, and improving its infrastructure.

PARTNERSHIP

The SMA program commenced in 1999, with the first two of the five planned programs, "Advanced Materials for Micro- and Nano-Systems" (AMM&NS) and "High Performance Computation for Engineered Systems" (HPCES), beginning in July 1999. The third program, "Innovation in Manufacturing Systems and Technology" (IMST), was introduced the following July, followed by the last two programs, "Molecular Engineering of Biological and Chemical Systems" (MEBCS) and "Computer Science" (CS), which began in July 2001.

The academic calendar, course content, grading method, and degree requirements are aligned with MIT practice and standards. Degrees are awarded by the host university, along with an SMA certificate confirming completion of the program of study.

Each program has a minimum of six SMA Faculty Fellows from MIT and six from Singapore. SMA Faculty Fellows commit to devoting fifty percent of their time to SMA.

Subjects are taught primarily via distance education (DE). However, MIT Faculty Fellows spend several weeks in Singapore engaging in face-to-face lecturing and research collaboration.

All SMA students spend at least two weeks at MIT during their matriculation; doctoral students spend a full semester at MIT. In addition, an annual symposium in Singapore is held to evaluate progress and enable students and faculty to interact with industry.

Research comprises an important aspect of the research master and doctorate degrees. Research students' theses are jointly supervised by an MIT and a Singaporean faculty member.

MANAGEMENT STRUCTURE

The SMA program is governed at three levels. At the top tier is the Governing Board, which comprises academic, government, and industrial leaders in Singapore, and members of the faculty and administration at MIT. At the next level down is the Joint Academic Committee, which comprises administration and faculty from MIT and meets quarterly (usually via video-conferencing). The individual academic programs are co-directed by Faculty Chairs from MIT and Singapore.

The administration of SMA is managed by two co-directors one from MIT and one from Singapore. The MIT Co-Director is Anthony T. Patera, who also serves as Director of the MIT Center for the Singapore-MIT Alliance.

DISTANCE LEARNING

MIT's Center for Advanced Educational Services (CAES), under the direction of Richard C. Larson, has assumed responsibility for the technology and operation of the distance learning aspects of SMA. SMA staff work closely with CAES staff in selecting modes of operation and necessary equipment through an SMA Distance Education Working Group jointly chaired by Anddie Chan and Mike Barker. In addition to CAES, SMA staff also work closely with MIT's Educational Media Creation Center and Information Services to implement high bandwidth connection for the distance education classes. Vijay Kumar, Assistant Provost, and Richard Larson, Director of CAES, are jointly responsible for the SMA's web-based platform development.

PRE-IMMERSION AND IMMERSION PROGRAMS

All SMA students spend two and a half weeks at MIT as part of the "Pre-Immersion" and "Immersion" programs, which are designed to help Singaporean students become immersed into the MIT environment. The "Pre-Immersion" component consists of discussions with entrepreneurs in their respective fields, and the "Immersion" component includes English language workshops, lectures and lab sessions taught by MIT faculty, as well as social gatherings and activities.

ENTERING CLASS

The target number of students for each program is fifty-four. Of these, approximately thirty are expected to be professional masters students enrolled in a one-year course of study, with the remainder comprising research masters and doctorate students.

In academic year 2001–2002, a total of 958 applications were received for the five programs operating, 297 offers were made, and 176 applicants accepted the offers. Of the 176, 44 percent were from China, 19 percent were from Singapore, 29 percent from India and the remainder from other South East Asian countries.

GRE scores were waived for students from top schools in Singapore. However, the student scores that were obtained compare favorably with the scores of students being admitted for graduate study in MIT's Departments of Mechanical Engineering and Materials Science and Engineering, and there has been a rise in both GRE and TOFL scores for the class of 2002. Offering students full fellowship support (including travel costs) for their entire matriculation has been a factor in recruiting top students.

PROGRAMS

All SMA programs offer both professional master's degrees (S.M. degree) and doctoral research degrees; some programs also offer research master's degrees (M.Eng. degree). All of the degrees include a core curriculum, with the addition of a master's thesis for the research master's degrees, and additional advanced courses and a doctoral thesis for the Ph.D. degrees.

Advanced Materials for Micro- and Nano Systems

The SMA degrees in Advanced Materials for Micro- and Nano Systems (AMM&NS) cover the fundamentals of electrical, optical, magnetic and mechanical properties of materials, and the fundamentals of processing of materials for high technology applications, with an emphasis on applications in microelectronics.

The AMM&NS S.M. degree is a 12-month program, including three subjects in the necessary fundamentals, and three electives with a focus on microelectronics. The degree also offers students an opportunity to carry out a semester-long research or industry project. The AMM&NS M.Eng. degree includes a similar, but more rigorous, core curriculum and a master's thesis jointly supervised by SMA Fellows from Singapore and MIT. The AM Ph.D. degree includes an expanded choice of elective subjects and a doctoral thesis.

The research collaborations growing from co-supervision of M.Eng. and Ph.D. student research has led to the submission of joint publications and presentations at an international conference. Joint research activities among the Alliance universities and Singaporean research institutes have also been initiated in a number of areas, especially in the area of metallization and materials reliability in microelectronics.

The MIT Chair of the AMM&NS program is Carl V. Thompson. Faculty members involved include Subra Suresh (Program Advisor), Lallit Anand, Dimitri A. Antoniadis, Craig Carter, Gerbrand Ceder, Joel P. Clark, and Eugene A. Fitzgerald as Faculty Fellows and Martin Schmidt and Mark Spearing as Associates.

High Performance Computation for Engineered Systems

The SMA program in High Performance Computation for Engineered Systems (HPCES) focuses on simulation and optimization of engineered systems. High performance computation is a crucial component in the modeling, simulation, design, optimization, control and visualization of engineered systems in a wide range of technology and service industries. Students learn to apply and develop advanced numerical techniques for simulation and optimization relevant to a diverse set of applications from aerospace, electrical, industrial, mechanical, and other engineering fields, as well as logistics, management, and finance.

The HPCES S.M., M.Eng., and Ph.D. degree programs all include a core curriculum, which is followed by a master's thesis for the M.Eng. degree, and several additional advanced courses and a doctoral thesis for the Ph.D. degree. The S.M. degree focuses on the critical and effective application, modification, and integration of existing simulation and optimization software; the M.Eng. and Ph.D. degrees emphasize the formulation, analysis, and implementation of new computational methods for the simulation and optimization of engineered systems.

The HPCES program has chosen the broad area of "Effective Computation for Design and Operation of Engineered Systems" as its primary research emphasis. There are already quite a few publications from the Singapore and MIT Fellows in conference proceedings and archival journals that cite SMA support.

The MIT Chair of the HPCES Program is Jaime Peraire. Faculty members involved include Thomas Magnanti (Program Advisor), Dimitris J. Bertsimas, Robert M. Freund, Thomas L. Magnanti, Anthony Patera (Co-Director), and Jacob K. White as Faculty Fellows, and Nicolas Hadjiconstantinou, Nitin Patel, Georgia Perakis, Andreas Schulz, Gilbert Strang, and Karen Willcox as Associates.

Innovation in Manufacturing Systems and Technology

Innovation in Manufacturing Systems and Technology (IMST) degrees offer competitive courses of study that explore the many facets of manufacturing technology. The coursework integrates the process, product, system and business aspects of industry, while focusing on the core of manufacturing systems. Advanced coursework exposes students to innovative theories and methodology, as well as to a rigorous investigation of financial, strategic and global aspects of technology innovation and new business generation.

The S.M., M.Eng., and Ph.D. degree programs all include a core curriculum. In addition to the core curriculum, the SM degree includes a theme project; the M.Eng. degree includes a Master's level research thesis; the Ph.D. degree includes additional subjects on advanced topics in each of the fundamental areas and a doctoral thesis.

The IMST S.M. degree program is aimed at practitioners who will use this knowledge to become leaders in existing, as well as emerging, manufacturing companies. The IMST M.Eng. and Ph.D. degree programs are designed to prepare students for careers in industrial research and development centers, research institutes or academic departments interested in fundamental research in manufacturing.

The MIT Chair of the IMST Program is David E. Hardt. Faculty members involved include Lallit Anand, Jung-Hoon Chun, Steven D. Eppinger, Stephen Graves, Lawrence M. Wein and Kamal Youcef-Toumi as Faculty Fellows and Stanley B. Gershwin as an Associate.

Molecular Engineering of Biological and Chemical Systems
The Molecular Engineering of Biological and Chemical Systems (MEBCS) program offers two degree programs—the S.M. degree and the Ph.D. degree—which integrate a molecular understanding of biological and chemical phenomena with advances in process engineering for the life sciences and fine chemical industries. Through a combination of cutting edge research and advanced coursework in molecular engineering sciences, graduates are poised for high level professional or research positions in thriving industries, new start-up companies, academic institutions, and research centers.

The S.M. degree program prepares graduates for shaping and solving complex industry problems, resource management, teamwork and leadership. The Ph.D. program prepares graduates for advanced careers in industrial research and development centers, research institutes or academic departments interested in biological and chemical engineering processes with emphasis on synthesis skills, engineering design and interdisciplinary approaches.

The MIT Chair of the MEBCS Program is Jackie Y. Ying. Faculty members Robert A. Brown (Program Advisor), Alan T. Hatton, Paul E. Laibinis, Harvey F. Lodish, Kenneth A. Smith, Gregory N. Stephanopoulos and Daniel I.C. Wang are Faculty Fellows and faculty member Bernhardt Trout as an Associate.

Computer Science
The SMA program in Computer Science (CS) covers the broad foundations of Computer Science, encompassing computer architecture, software systems, algorithms and advanced applications.

The CS S.M. degree is a one-year professional degree program, which incorporates coursework that prepares graduates for careers in the development of advanced computer systems. It is aimed at training students to apply their knowledge of Computer Science to industrial problems, particularly in the development of large software systems and embedded computing. The CS Ph.D. degree program is a research program that provides the necessary depth to equip graduates for careers in industrial research and development centers, research institutes or academic departments interested in cutting-edge research in all aspects of Computer Science.

The MIT Chair of CS is Charles Leiserson. Faculty members Tomas Lozano-Perez, Saman P. Amarasinghe, Arvind, Leslie Kaelbling, Stuart Madnick and Martin Rinard are Faculty Fellows.

BENEFITS AND GOALS
Singapore's goals for SMA include invigorating engineering education within its top universities, enhancing creativity and entrepreneurship in its educational system, and attracting talented young people to Singapore.

Benefits of the SMA program for MIT are that this highly focused, well-funded alliance provides the opportunity to develop new modes of operation based on communications technology. MIT's goals for the program are to broaden MIT's role as a global university, to define a unique style of contact-intensive distance education, and to learn how to bring this global interaction to MIT as a means of enhancing undergraduate and graduate education for all of MIT's students.

We anticipate strengthened departmental curricula as a result of SMA funded new and existing subject development. We also anticipate enhanced inter-departmental and inter-school collaborations as a result of both SMA curriculum development and SMA funded research projects. Several of the programs cross-list their courses to provide MIT students with the opportunity to engage in distance learning.

The Singapore-MIT Alliance looks forward to leading the world in distance education.

More information about the Singapore-MIT Alliance can be found at http://web.mit.edu/sma/.

Anthony T. Patera

SYSTEM DESIGN AND MANAGEMENT

The mission of the System Design and Management Program (SDM) is to educate future technical leaders in architecture, engineering, and designing complex products and systems, preparing them for careers as the technically grounded senior managers of their enterprises. SDM intends to set the standards for delivering career-compatible professional education using advanced information and communication technologies. SDM was one of MIT's early entries into the field of distance education and remains the only degree-granting program at MIT that can be earned primarily from a remote location.

The SDM program is a joint offering of the School of Engineering and the Sloan School of Management, leading to a Master of Science degree in engineering and management. Targeted for professional engineers with three or more years of experience, the program centers on a 13-course curriculum in systems, engineering, and management, including a project-based thesis. It offers three curricular options: a 13-month in-residence format; a 24-month distance education for company-sponsored students, requiring one academic semester in-residence at MIT; and a 24-month on-campus program for self-supporting students who can obtain a research assistantship in one of MIT's labs or centers. The program was conceived as an alternative to the MBA for professional engineers, allowing working professionals to pursue a degree without interrupting their careers and relocating themselves and their families.

Denny Mahoney, Director of SDM Fellows, completed his second year in that position, providing a much-needed stability to program leadership. Co-Directors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger. As of July 1, 2001, Steve Eppinger, General Motors Leaders for Manufacturing (LFM) Professor of Management at the Sloan School of Management, will assume the LFM-SDM Co-Director's position when Steve Graves will be appointed Chair of the Faculty.

STUDENT STATISTICS

In January 2001, SDM admitted its fifth class, enrolling 37 students. In all, 11 organizations sponsored students in the incoming class, including LFM-SDM partner companies: United Technologies Corporation (UTC) (3), Ford Motor Company (10), National Aeronautics and Space Administration (NASA) (10), Eastman Kodak (1).

In June 2001, SDM graduated its third full class. Forty of the 49 graduates attended the commencement ceremony to receive their degrees—a testament to the cohesiveness of this distance education group. The graduating class includes 11 employees from Ford, 10 from UTC, eight from Xerox, one from Eastman Kodak, as well as employees from Polaroid, Visteon, GM Delphi, GTE, Honeywell, Intel, the U.S. Navy, and Gemcor.

SDM continues to draw from a wide range of companies for its students. This past year, ArvinMeritor sponsored three students in the January 2001 class and has expressed interest in participating in the LFM-SDM partnership. Xerox, a long-time supporter of SDM, did not sponsor any employees this year because of difficult economic times for the corporation. United Technologies Corporation, which usually enrolls a significant number of employees into each SDM cohort, only sponsored three employees in SDM who were all from Pratt & Whitney, one of UTC's divisions. Several other business units within UTC, most notably Sikorsky and Otis Elevator, which normally sponsors students in SDM, did not do so last year because of internal reorganization. UTC, however, expects to increase its overall participation in SDM in the next intake as a result of a new educational partnership.

Table 1. System Design and Management Admissions Statistics

	1997	1998	1999	2000	2001
Admitted	35	58	47	50	37
On-Campus	8	16	6	14	8
Self-Supported	3	1	2	5	2
Research Assistant	3	12	2	4	3
Distance Education	27	42	41	36	29
Company-Sponsored	29	45	43	41	32

SYSTEM INTEGRATION PROJECT

This past year, LFM-SDM and UTC embarked on a new educational venture. UTC has identified 11 core capabilities that the corporation believes must be strengthened across all the business units for UTC to remain competitive in the next century. For each capability, UTC will partner with a university that can deliver the highest quality education to its workforce in each of these areas. UTC proposed that LFM-SDM serve as its partner for one of these competencies—Systems Engineering. UTC believes that much of the current SDM curriculum addresses many of the

required capabilities needed for systems engineering that they have identified as important across the UTC business units.

The project team has segmented the educational process into four target populations—a group of experts enrolled in the SDM program, a second group of experts enrolled in UTC-MIT's Systems Integration Certificate Program, the managers/facilitators of the experts, and implementers/doers. A holistic approach recognizes that each target population is part of a larger whole and tries to identify the critical points and people in a process where new knowledge must be applied.

The project team identified the certificate program as its priority, and a pilot class of 12 students will begin the new certificate program starting fall 2001. It is expected that this project will not only provide the Institute with an important experiment in lifelong learning, but will also solidify a higher level of enrollment by UTC employees in the regular SDM program.

DISTANCE EDUCATION DELIVERY

As MIT's premier degree program offered at a distance, SDM has recognized its leadership role at the Institute regarding the practice of distance education and is in a process of evaluating its delivery with the goal of increasing the quality of the remote-learning experience while reducing costs.

Specific distance education accomplishments include:

- SDM's continuation to deliver the full range of SDM course offerings to all of its students;
- The adaptation of other courses for the distance education medium of multi-point videoconferencing to as many as 15 simultaneous company sites;
- Jan Klein's funding by NASA and Ford Motor Company on a proposal to apply her research on Virtual Teams to improving the SDM distance learning experience. She conducted a survey and will introduce and measure specific change elements into the program;
- SDM's efforts to experiment with new distance formats. For example, when SDM students could not get into Rebecca Henderson's Technology Strategy course because of over-enrollment, SDM program administrators created a course format in which SDM distance students received the core of Henderson's teaching via videotape. This included videoconference recitations and a half-day workshop on campus facilitated by Henderson herself. A similar approach was taken with Steve Eppinger's Product Design and Development course in the spring.
- Another experiment with Systems Dynamics, in which Jim Hines, a senior lecturer in the Sloan School, is offering a web-based, asynchronous course to SDM students both on and off campus, during summer 2001.

SDM will continue to explore effective ways of making course materials available to distance students.

More information about the System Design and Management Program can be found at http://sdm.mit.edu/.

William C. Hanson

TECHNOLOGY AND POLICY PROGRAM

The MIT Technology and Policy Program (TPP) provides an integrative education to scientists and engineers who wish to lead in the development and implementation of responsible strategies and policies for exploitation of technology for the benefit of their communities. TPP's guiding vision is the education of "Leaders Who Are Engineers and Scientists."

The TPP graduate educational program in the School of Engineering acknowledges that the development of the skills necessary for effective implementation of technology tie into the emerging engineering systems educational thrusts and, consequently, TPP is part of the Engineering Systems Division (ESD) of MIT. The program focuses on providing a high impact, high quality education to its students. Its goal is to make TPP the most prestigious and sought after technology policy program in the world and to produce the technological decision makers of the future.

TPP sponsors both a Master of Science program and the Technology, Management and Policy (TMP) doctoral program. This year's class of Master of Science in Technology and Policy included 48 graduates, and 2 continued on as doctoral students. This year's "Best Thesis in Technology and Policy" was awarded to Robert Hyman. The TMP program has a current enrollment of twenty students, reflecting a steady-state admission rate of about five students per year. Seven students received their Technology, Management and Policy Ph.D. in June 2001.

Esther Kim received the Grossman Award and will be using it to undertake an internship in Nepal.

The close of Professor Hasting's first full academic year as Director of TPP is also marked by a number of achievements stemming directly from the strategic plan developed during the first semester of his tenure. The TPP Faculty Council has helped to broaden the intellectual footprint of TPP within the Institute, drawing upon faculty not only from the School of Engineering and the School of Management, but also from the School of Humanities and Social Sciences. As a consequence to the Sussman Curriculum Committee report, TPP has funded several curriculum development efforts, including a complete reworking of a key core course, ESD.11 (now ESD.10). This curriculum development has also been coordinated with a concurrent effort with the Cambridge-MIT Initiative, and new offerings will start at Cambridge during the upcoming Michaelmas Term. Finally, TPP and ESD hosted the first of what will be an annual event designed to raise both the external and internal profile of the Program. This year, TPP and ESD hosted a symposium marking the 25th year of the Office of Science and Technology Policy, bringing together not only almost all the past heads of the office, but also academics and professionals in the field of technology policy to reflect upon the history of the office, as well as to consider the challenges facing practitioners of technology policy today.

Finally, this year marked another transition for TPP—Ms. Gail Hickey, who had worked with TPP for the last 15 years, left the program to pursue other interests. Her years of outstanding service were recognized at the 2001 MIT Awards Ceremony where she was given the James N. Murphy award.

More information about Technology and Policy Program can be found at http://mit.edu/tpp/www/.

Daniel Hastings

TECHNOLOGY, MANAGEMENT, AND POLICY

The Technology, Management, and Policy Program (TMP) is an interdisciplinary Ph.D. program directed at producing world-class researchers striving to improve methods used in defining and implementing policies for the intelligent use of technology. The program was established in 1992 and became a part of the Engineering Systems Division in 1998. The students within the program are motivated by their recognition of specific problems at the boundaries between technological development and social and industrial policy. The goals of the TMP program are to supply an academically rigorous environment within which these students, under the guidance of MIT faculty, work to extend the nature and purview of the tools needed to understand and address these issues.

The common vision of the program participants is that a dual competency in a technical area and in management and policy is the basis for the effective design of large-scale systems. The research efforts within the program are leading to the development of a new paradigm for the planning and design of engineering systems—a paradigm that blends technical expertise with competence in economics, management, and policy to achieve a better adaptation of technology to societal goals.

Students are not directly admitted to the program; rather, they are first admitted to the Master's program in Technology and Policy. Upon their arrival at MIT, these potential TMP students then prepare a case for admission to the TMP program, which requires that they: construct an appropriate research question; assemble a cadre of MIT faculty committed to that effort; and develop a proposed curriculum that will assure that the student will be equipped to address this question in a manner consistent with the highest academic standards of the fields represented. This admission case is then reviewed by the TMP admissions committee, composed of faculty drawn from the MIT Schools of Engineering; Management; and Humanities, Arts, and Social Sciences.

Although the majority of the students in the program initially came to MIT solely for the S.M. in Technology and Policy Program (TPP), there has been an upsurge in applicants who have specifically targeted admission to TMP over the past three years. The program currently admits about five students each year, and students take approximately five years to complete their degrees. There currently are 20 students enrolled in the TMP program, and five new students were admitted. Seven TMP Ph.D.s were awarded this year and these graduates have joined their colleagues in careers in industry, academia and the government.

A new TMP program statement was constructed by the TMP Faculty Committee, chaired by Professor Daniel Hastings. This document sharpens the definition of the TMP degree, as well as establishing a set of formal requirements and procedures for the program. In addition to modifying the admissions process, the intellectual context for the degree is outlined, and the associated educational requirements are summarized.

More information about Technology, Management, and Policy can be found at http://mit.edu/tpp/www/.

Daniel Hastings

DEAN, SCHOOL OF HUMANITIES, ARTS, AND SOCIAL SCIENCES

The year 2000 marked the 50th anniversary of the establishment of the School of Humanities, Arts, and Social Sciences at MIT. Previously known as the School of Humanities and Social Science, on July 1, 2000 we added the Arts to our name in recognition of great progress the Arts have made at MIT in the past fifty years. To recognize our golden anniversary, we organized a series of events that formed an exciting tribute to the School. On September 21, 2000, we opened a significant exhibition in Compton Gallery entitled "A Fifty-Year Reflection: Humanities, Arts, and Social Sciences at MIT." The exhibition ran through January 2001 in Compton, and in May it was relocated to a permanent site on the ground floor corridor of Building 14. It was curated by Professor Kenneth Manning of the programs in Writing and Humanistic Studies and Science, Technology and Society in cooperation with Director Jane Pickering and the staff of the MIT Museum.

On October 6 and 7, 2000 an extraordinary group of scholars and artists participated in a colloquium entitled "Asking the Right Questions." Featured were Institute Professor Noam Chomsky (Linguistics and Philosophy), Professor Steven Pinker (Brain and Cognitive Sciences), Professor Hilary Putnam (Philosophy Department, Harvard University), Institute Professor John Harbison (Music and Theater Arts), Professor Anita Desai (Writing and Humanistic Studies), Professor Louise Gluck (English Department, Williams College), Professor John Dower (History Faculty), Professor Pauline Maier (History Faculty), Professor Gillian Beer (English Department, University of Cambridge), Institute Professor Robert Solow (Economics), Professor Suzanne Berger (Political Science), and Professor Kenneth Arrow (Economics Department, Stanford University). A publication based on the colloquium presentations will appear in the fall of 2001 under the co-editorship of Professor Manning and Professor Joshua Cohen (Linguistics and Philosophy and Political Science), who organized and chaired the colloquium.

On the evening of October 6, the MIT community was treated to a series of magnificent performances by the MIT Symphony and other MIT musical groups and ensembles, organized by the Music and Theater Arts Section. Our celebration culminated on the evening of October 7 at the Museum of Fine Arts in Boston. The evening began with an awards ceremony at which 50th Anniversary Medals were presented to Professors Beer, Putnam, Arrow and Gluck, followed by a gala dinner and dance for over 400 guests including many members of the MIT Corporation, MIT's senior administration, and emeriti faculty in the School of Humanities, Arts, and Social Sciences. At the dinner, we announced the establishment of the Robert A. Muh Alumni Award in the Humanities, Arts, and Social Sciences and introduced to the assembled guests its first incumbent, the dancer and choreographer Gus Solomons Jr. President Charles M. Vest concluded the evening by announcing the establishment of the $75 Million Kenan Sahin Fund for the School of Humanities, Arts, and Social Sciences. Dr. Sahin then offered comments on the great importance of the School to the life and success of the Institute.

A 30-minute video that captures the highlights of the entire two-day 50th anniversary celebration is available from the Dean's Office.

In March, Gus Solomons Jr. '61 (Architecture) returned to campus to teach an inspired master class in dance and choreography and to receive the first Robert A. Muh Alumni Award in the Humanities, Arts, and Social Sciences at a dinner in his honor attended by Robert and Berit Muh and many members of the MIT arts community.

Meanwhile, the School continues to build and refine its undergraduate and graduate programs and to focus its efforts on fund-raising, affirmative action and faculty recruitment in departments, sections and programs which are experiencing retirements and resignations. The faculty received a number of honors and awards, and some important administrative changes within the School have occurred.

UNDERGRADUATE EDUCATION

From all indications, the simplification of the HASS-D Requirement which took effect fall 2000 seems to have been successful in reducing confusion concerning this requirement. (Students are now simply required to take three HASS-D subjects from three different categories, with the HASS-D Language Option still an option.) There were fewer questions from students and advisors, and most importantly, for the first time in many years, there were no last-minute crises involving graduating seniors who had not completed the HASS-D Requirement.

This was the third year of the pilot phase for HASS Communication Intensive (CI) subjects and the last year before implementation of the new Communication Requirement in fall 2001. Because students ordinarily will take HASS CI (CI-H and CI-HW) classes their first two years, considerable capacity is required in these classes. Thus, much time and effort—both on the part of the HASS Office and the HASS Overview Committee (HOC)—was expended in getting this new system in place. The HOC, chaired by Professor James Buzard, reviewed over 100 proposals and finally recommended 87 for HASS CI status to the Committee on Curricula (COC) for the 2001–2002 academic

year. The COC affirmed the work of the HOC by approving the entire list. These classes will be available to freshmen, the Class of 2005, who will be subject to the new Communication Requirement, as well as to upperclassmen who can use them to fulfill Phase I of the Writing Requirement. In addition to reviewing proposals, the HOC spent time discussing various topics related to HASS CIs, including criteria for HASS CI subjects and funding for writing tutors to assist the instructors. The HASS Office maintains the HASS CI database, which includes all pilot HASS CIs as well as those approved for 2001–2002.

NEW INITIATIVES

In spring 2001 the Program in Writing and Humanistic Studies received approval from the MIT faculty for the creation of a new masters program in Science Writing, with the educational mission of improving the public understanding of science. This program seems particularly relevant to MIT, where excellence in scientific research is a hallmark. The graduate program will be directed by Professor of Science Writing Robert Kanigel and will draw on the talented teaching staff of the Program in Writing and Humanistic Studies. The Program hopes to hire an additional faculty member to teach and administer the new degree program, and plans to accept its initial group of students in September 2002.

AFFIRMATIVE ACTION

The affirmative action record of SHASS continues to appear strong relative to the rest of the Institute, but this is mainly because the representation of women within the fields of humanities and social science is relatively large. In fact, the total number of women faculty had been steadily increasing for several years—from 35 women in AY1993 to a peak of 49 in AY2000—until this year, when we witnessed a decline of two women faculty. Within the School for 2000–2001 there were 47 women faculty, representing 31 percent of the total faculty; of these, 31 are tenured (30 percent of the tenured faculty). And while we were successful in recruiting three women to the faculty (2 tenured/1 untenured) for next academic year (2001–2002), we will experience a net decrease of two women, bringing the number of women faculty down to 45, due to retirements, spousal/partner relocation, recruitment efforts by competing universities, and the unsuccessful promotions of some of our junior women faculty. Of the two SHASS faculty promoted internally and approved for tenure in AY2001 (to be effective July 1, 2001), one was a woman, but unfortunately, she accepted a position at Stanford to be closer to her partner.

The School has had moderate success in its efforts to recruit minority faculty. Although we successfully recruited two Asian American women (1 tenured/1 untenured) to join our faculty effective AY2002, we will experience a net increase of only one additional minority due to the loss of one Asian American assistant professor in Political Science. The total number of minority faculty in the School this year, including Asian Americans, was 20, and next year (AY2002) we will have a total of 21. With the help of the Provost's Initiative, we hope to step up our efforts to recruit qualified women and minority candidates.

We remain committed to increasing the minority representation of the administrative staff. Currently, we have only three minorities (one Hispanic and two Asian-Americans) of a total of 32 (approximately 9 percent). We hope to further diversify our administrative staff by working closely with the Departments and Programs in the School and with the Office of Human Resources.

HONORS AND AWARDS

The faculty within the School of Humanities, Arts, and Social Sciences garnered an array of honors and awards this year. The most notable among them were the following: Elting E. Morison Professor of History John Dower's Pulitzer-Prize winning book, *Embracing Defeat: Japan in the Wake of World War II*, continued to receive numerous honors, including the PEN/New England L.L. Winship Award, the Mark Lynton History Prize from Harvard University, and an American Library Association Notable Book award. Professor of Philosophy and Political Science Joshua Cohen was awarded The Leon and Anne Goldberg Professorship in Humanities. Esther Duflo was chosen as the Castle Krob Career Development Assistant Professor of Economics and received the 2001 John M. Olin Faculty Fellowship. Assistant Professor of Theater Arts Thomas DeFrantz received the Class of 1948 Career Development Professorship. David Kaiser of the Program in Science, Technology and Society (STS) was awarded the James Levitan Prize in the Humanities and appointed as the Leo Marx Career Development Assistant Professor in the History and Culture of Science and Technology. Anne McCants was appointed as the first recipient of the William and Betsy Leitch Associate Professor of History in Residence. Professor of History Peter Perdue was appointed the first holder of the T. T. and Wei Fong Chao Professorship in Asian Civilizations. Professor of Political Science and Economics James M. Snyder, Jr. was awarded The Arthur and Ruth Sloan Professorship in Political Science. Professor of Literature Peter S. Donaldson was selected as a recipient of the MIT Class of 1960 Innovation in Education Award. The Department of Economics' Professor Joshua Angrist was appointed to the Editorial Board of the American Economic Review; Associate Professor Dora Costa received the Economic History Association's Alice Hanson Jones Book Prize, 2000, for *The Evolution of Retirement: An American Economic History, 1888–1998*; Institute Professor of Economics Peter Diamond was nominated to be the President of the American Economic

Association, 2002; Ford International Professor of Economics Rudiger Dornbusch was named Distinguished Fellow of the American Economic Association; Professor Glenn D. Ellison was elected as Fellow of the Econometric Society; and Franklin Fisher, Jane Berkowitz Carlton and Dennis William Carlton Professor of Microeconomics, was awarded an honorary doctorate from Hebrew University of Jerusalem and was named the 2001 Ida Cordelia Beam Distinguished Visiting Professor of the University of Iowa. Professor of Sociology and Anthropology Susan Silbey was elected a Fellow of the American Academy of Political and Social Science. Associate Professor Deborah Fitzgerald, Director of Graduate Studies for the History and Social Study of Science and Technology (HSSST), received the Perkins Award for Excellence in Graduate Advising at the MIT Awards Convocation. Assistant Professor of Economics David Autor was given First Prize, Milken Institute Award for Distinguished Economic Research and received the 2001 Steven H. Sandell Grant for Junior Scholars in Retirement Research. Associate Professor of Political Science Melissa Nobles was awarded a Fellowship from Boston University's Institute on Race and Social Division and received the 2000 Outstanding Book Award for her book, *Shades of Citizenship*, from the National Conference of Black Political Scientists. Elizabeth and James Killian Professor of Economics and Management Paul L. Joskow was elected Vice President of the International Society for Institutional Economics and reappointed to the EPA Advisory Board. The Department of Linguistics and Philosophy's Associate Professor of Philosophy Sally Haslanger received a 2001 Fellowship from the American Council for Learned Society; Professor of Linguistics David Pesetsky was appointed Henrietta Harvey Distinguished Lecturer at Memorial University, Newfoundland; Professor of Philosophy Irving Singer has been appointed a Fellow of the European Humanities Research Centre at Oxford University, England; Associate Professor of Philosophy Ralph Wedgwood was awarded the Young Epistemologist Prize at the Rutgers Epistemology Conference in 2001; and Associate Professor of Linguistics Cheryl Zoll received a 2002 Bunting Fellowship from the Radcliffe Institute of Advanced Studies. Bengt Holmstrom, Paul A. Samuelson Professor of Economics, was appointed to The Swedish Royal Academy of Sciences. Professor of History and Philosophy of Science Evelyn Fox Keller was awarded the 2001 L.L. Winship/PEN New England Award for her book, *The Century of the Gene*, and an honorary doctorate from Wesleyan University. The Department of Economics' James Poterba, Mitsui Professor of Economics, and Professor Nancy L. Rose were appointed 2001 George and Karen McCown Distinguished Visiting Fellowships at the Hoover Institution. Professor Poterba was also elected to the Executive Committee of the American Economic Association, 2001–2003. Professor of Literature Ruth Perry received the American Society of Eighteenth Century Studies Award for outstanding women in eighteenth century studies. Associate Professor of History Jeffrey Ravel's book, *The Contested Parterre: Public Theater and French Political Culture, 1680–1791*, won the Barnard Hewitt Award from the American Society for Theater Research. Associate Professor of Economics Jaume Ventura received the MIT Graduate Economics Association "Best Teacher" Award, 2000–2001. Associate Professor of Theater Arts Janet Sonenberg was awarded a Margaret MacVicar Faculty Fellowship. Peter Temin, Elisha Gray II Professor of Economics, was awarded a 2001 Guggenheim Fellowship. Dean Philip S. Khoury was elected an Alumni Trustee of Trinity College.

FUNDRAISING

New gifts and pledges for FY2001 total $7,824,603.59. With the $75 Million from the Kenan Sahin gift, the School total is $82,824,603.59.

Fundraising highlights include:

- Assignment of $75M of the Kenan Sahin, '63 GM, gift to the School of Humanities, Arts, and Social Sciences.
- French Ministry of Foreign Affairs support for MISTI France Professorship ($1M+) to be matched by MIT/School of Humanities, Arts, and Social Sciences fundraising efforts.
- Pledge payments brought professorship funding up to levels to permit new appointments to be made: the Leon and Anne Goldberg Professorship in the Humanities, Professor Joshua Cohen; the T. T. and Wei Fong Chao Professorship in Asian Civilizations, Professor Peter Perdue; and the completion of S. C. Fang Professorship in Chinese Language and Culture, Professor Jing Wang.
- Substantial increase to the Washington Summer Internship Program, including a $500,000 commitment from Dana Mead, PO '67.
- New Support for Economic Fellowships including a new commitment from Kenneth Wang, '72 EC.
- Robert, '59 MG, and Berit Muh provided support for a prize to recognize MIT alumni/ae contributions in Humanities, Arts, and Social Sciences. First award ceremony was in March 2001.

The top School fundraising priorities continue to be increased support for fellowships, professorships and faculty/program resources. Specific program priorities include the Shakespeare Archive, Bilingual/Bicultural Studies, Writing and Humanistic Studies, especially the new masters level program in Science Writing and the MIT Science and Technology Initiative (MISTI) Programs.

FACULTY PROMOTIONS, ADMINISTRATIVE CHANGES, RETIREMENTS

This year has seen two retirements, seven resignations and ten new faculty appointments within the School. Among the faculty retirements were Jeanne Bamberger (Music and Theater Arts) and Wayne O'Neil (Linguistics and Philosophy). Among the resignations were two associate professors (one whom had just received tenure in Economics and one nontenured in Writing and Humanistic Studies), two full professors (Jed Buchwald of STS and the Dibner, and Alan Lightman of Writing and Humanistic Studies), and three assistant professors, including two in Political Science and one in STS. While Alan Lightman will step down as a tenured faculty member, he has agreed to a part-time appointment as Adjunct Professor. A total of two faculty members in the School were promoted to tenure this year, effective July 1, 2001: Susan Athey of the Department of Economics, although she accepted a position at Stanford University in order to be closer to her partner, and Kai von Fintel of the Department of Linguistics and Philosophy.

The School was successful in recruiting a total of ten new members to the faculty during 2000–2001. Nine of the new faculty (two tenured/seven nontenured) will join us effective AY2002, while one, Donca Steriade (who will join the Linguistics and Philosophy Department as a full professor) will join us in AY2003. Of the nine, two will join the faculty as full tenured professors (Susan Silbey, Anthropology, and Jing Wang, Foreign Languages and Literatures); one as a non-tenured associate professor (Roger Peterson, Political Science); and six as assistant professors.

Academic Year 2000–2001 brought two additional women to School Council as new department heads Ellen Harris and Susan Slyomovics assumed leadership of Music and Theater Arts and Anthropology respectively.

More information about the School of Humanities, Arts, and Social Sciences can be found online at http://web.mit.edu/shass/.

Philip S. Khoury

HUMANITIES, ARTS, AND SOCIAL SCIENCES OFFICE

This was another extremely busy year in the HASS Office. In addition to all on-going projects and tasks, considerable time and energy was devoted to preparation for the implementation of the Communication Requirement in fall 2001. The HASS Office provides all administrative and clerical support to the HASS Overview Committee (HOC), which spent the year reviewing proposals for HASS Communication Intensive (HASS CI, consisting of CI-H and CI-HW classes) subjects, as well as handling other matters related to HASS CIs—criteria, tutors, etc. In the spring, HOC recommended the final list of HASS CIs to the Committee on Curricula (COC), which approved it *in toto*. The HASS Office Coordinator, Dr. Bette Davis, serves as *ex officio* member of the HOC. The administrative assistant maintains the web list of HASS CI subjects and the HASS CI database. The latter contains information on all HASS CIs that have been offered during the past three-year "pilot phase," as well as those approved as official HASS CIs effective fall 2001. The CI database makes a total of five databases that this small office maintains; others are the HASS Minor, Course 21 majors, Harvard Cross-Registration, and "mailing list" databases.

The Coordinator, Bette Davis, served as a member of the "Advising at MIT Discovery Project" Stakeholders group. Very briefly stated, the purpose of that project was to determine how information technologies could be used to improve advising at MIT.

HASS ENROLLMENT STATISTICS BY FIELD AND SUBJECT - RECENT TRENDS

Total enrollments in all HASS subjects were down by about 300—9828, compared to 10,132 in AY2000. Correspondingly, there were fewer HASS subjects offered—466, compared to 478 in 1999–2000. The number of autonomous sections was down slightly—598, compared to 609 in AY2000. The number of HASS-D subjects taught was almost exactly the same, 117, compared to 118 last year. The two fields with the largest overall enrollments were the same as last year, in the same order: 1803 in Economics (up from 1745 last year) and 1515 in Foreign Languages and Literatures (about the same as last year, 1509). Literature (958) and Writing (908) reversed order for third and fourth highest enrollments. Next were Music (684 not including six-unit music performance), and History (617). Most fields either saw a drop in enrollment or remained stable. However, Archaeology again had the largest increase over last year in terms of percentage (from 147 to 166, or 13 percent), followed closely by Political Science (from 467 to 521, or 12 percent). The next highest increases in enrollment, in terms of percentage, were in Literature, with a 4 percent increase, and Economics, with a 3 percent increase.

HASS CONCENTRATIONS: PATTERNS OF POPULARITY

In 2000–2001, students submitted 2184 HASS Concentration proposals and 1183 completion forms, compared to 2229 proposals and 1267 completion forms last year. Once again, Economics and Foreign Languages led in the number of completed HASS Concentrations: in 2000–2001, 341 (compared to 367 last year) students completed concentrations in Economics, and 213 completed concentrations in Foreign Languages and Literatures, compared to 236 last year. (For a breakdown by languages, see Table II.) The next two most popular HASS Concentration fields are Music, with 94 completed concentrations, and Literature, with 77, followed by Philosophy (55), Writing (54), and Psychology (50).

HASS MINOR PROGRAMS

2000-2001 showed an increase in the total number of HASS Minor applications from all graduating classes; however, the number of HASS Minors received by the Class of 2001 was down— 173, compared to 225 last year. There were 439 applications, compared to 414 last year and 475 in 1998–1999. The two most popular fields in terms of applications filed were the same as last year: Economics (168) and Music (47). There were 44 minors in Foreign Languages (7 in French, 16 in German, and 21 in Spanish). Other popular HASS Minors were Writing (29), Political Science (23), and Literature (22). The 173 HASS minors received by members of the Class of 2001 were in 22 fields.

HARVARD CROSS REGISTRATION

The number of MIT undergraduates cross-registered for courses at Harvard increased in 2000–2001. 246 students took 290 subjects at Harvard, compared to 204 students enrolled in 220 subjects in 1999–2000. Last year there was a decrease in these enrollments; the previous year there had been a sizable increase; they seem to fluctuate for no obvious reason. As usual, foreign languages were by far the most popular field of study. 139 of the 290 subjects

were in 21 different foreign languages. The most popular language was Arabic (28). There was a three-way tie for second—among Korean, Russian, and Urdu-Hindi (11 each). These were followed by Italian and Greek (10 each), and Hebrew (8). Enrollments in other languages ranged from one to seven. The most popular fields outside foreign languages were Economics (28), History (16) and Government (15), followed by Art/Visual Studies (11) and English (9).

S.B. DEGREES GRANTED IN SHASS

89 students received the S.B. in SHASS this year, down from 94 last year. Of these, 41 degrees were in Economics (Course 14) and 9 were in Political Science (Course 17). During the same time period, September 2000 through June 2001, a total of 32 students completed the S.B. Degree in Humanities (Course 21). Eight of these received joint degrees, 5 in 21-E and 3 in 21-S. Another 20 received degrees in a specified field within Course 21. Six students received the S.B. in Philosophy and one received the S.B. in Linguistics and Philosophy (Course 24).

UNDERGRADUATE MAJORS IN SHASS

The four departments in SHASS had 135 undergraduate majors this year; this figure includes only first degrees. Eighty-four of these are majoring in Economics, and the Political Science Department had 16 majors. Twenty-five students had a Humanities major as their first degree in 2000–2001; of these, 8 were joint majors (7 in 21-E and 1 in 21-S.) Of the specified majors within Humanities, History and Literature had the most majors, 6 in History and 4 in Literature. Ten undergraduates had a first degree in Philosophy or in Linguistics and Philosophy.

HONORS AND AWARDS GRANTED TO UNDERGRADUATE MAJORS IN SHASS

Among the more notable honors achieved by SHASS majors this year were:

Robert A. Boit Writing Prize: *1st Place Poetry and Honorable Mention Short Story, Kanika Agrawal '01*

Burchard Scholars: *Rima Arnaout '02, Mendel Chuang '02, Daniel Feldman '02, Melissa Edoh '02, David Foxe '03, Remi Fujii '02, Alexander Hasha '02, Julie Hong '02, Radha Iyengar '02, Jimmy Jia '02, Jenny Lee '02, Joyce Lee '02, Jenny Lin '02, Toh Ne Win '02, Kathryn Nichols '02, Lynn Punnoose '03, Karen Robinson '02, Kris Schnee '02, Leah Schmelzer '02, Jennifer Son '02, Alice Takhtajan '02, Daniel Tortorice '02, Kaitya Vadgama '02, Michael Vogel '02, Siobhan Walsh '02, Vikram Maheshri '03*

John S. Hollywood Award: *Zhelinrentice Scott, '01*

I. Austin Kelly III Essay Prizes: *Lianne A. Habinek '02; Jeffrey Vieregg '01*

I Austin Kelly III & Richard Douglas Traveling Fellowship: *Lianne A. Habinek '02; Joyce W. Lee '02*

Peter J. Eloranta Fellowship: *Landi Parish '02*

Roger de Friez Hunneman Prize: *Philip Osafo-Kwaako '01*

Philip Loew Memorial Award: *Matthew Snow '02*

Ragnar and Margaret Naess Awards: *Mary Tsien'01*

Phi Beta Kappa: *Jonna B. Anderson '01; Riaz S. Dhanani '01; Cristina Estrada '01; Michael D. Frakes '01; Lynn C. Johnson '01; Douglas L. Kriner '01;Laura M. Moulton '01;Philip Osafo-Kwaako '01; Terrence C. Poon '01; Philip B. Tan '01; Jeffrey R. Vieregg '01*

Prize for Writing Science Fiction: *Second Place, Dawn Ash '02*

Malcom G. Kispert Award: *Cristina Estrada '01*

Assoc. of MIT Alumnae Senior Academic Award: *Cristina Estrada '01*

Gregory Tucker Memorial Prize: *Ivan Middleton '01*

More information about this department can be found online at http://web.mit.edu/hass/www/.

Bette Davis

Table 1. Enrollment in Humanities, Arts, and Social Science Subjects, 2000-2001

Field	Elective Subject			HASS-Distribution			Total Enrollment		
	#Subjects	(#Sections)	#Students	#Subjects	(#Sections)	#Students	#Subjects	(#Sections)	#Students
Anthropology	16	(16)	179	6	(6)	142	22	(22)	321
Archaeology	6	(6)	120	1	(1)	46	7	(7)	166
Economics	20	(39)	1,730	3	(3)	73	23	(42)	1,803
Foreign Languages & Literature	63	(96)	959	25	(43)	556	88	(139)	1,515
History	30	(30)	344	13	(13)	273	43	(43)	617
History of Art and Architecture	1	(1)	25	4	(4)	120	5	(5)	145
Linguistics	7	(7)	123	0	(0)	0	7	(7)	123
Literature	37	(40)	394	19	(30)	564	56	(70)	958
Music*	23	(27)	309	8	(14)	375	31	(41)	684
Philosophy	19	(19)	167	6	(6)	416	25	(25)	583
Political Science	25	(25)	269	8	(8)	252	33	(33)	521
Psychology	6	(6)	206	1	(1)	293	7	(7)	499
STS	12	(12)	56	5	(5)	143	17	(17)	199
Theater Arts*	18	(23)	255	3	(3)	37	21	(26)	292
Urban Studies	13	(13)	184	1	(1)	3	14	(14)	187
Visual Arts	6	(6)	76	2	(4)	76	8	(10)	152
Women's Studies	13	(13)	29	4	(4)	50	17	(17)	79
Writing	32	(61)	760	6	(8)	148	38	(69)	908
Other Subjects	2	(2)	27	2	(2)	49	4	(4)	76
Totals	**349**	**(442)**	**6,212**	**117**	**(156)**	**3,616**	**466**	**(598)**	**9,828**

Notes:
1. Figures were obtained from the MITSIS system, which shows the final tally for each class.
2. The numbers shown are for undergraduate subjects which normally satisfy the HASS Requirement; they do not include subjects allowed by petition.
3. (#Sections) refers to the number of autonomous class sections; it does not apply to subjects which meet in a single lecture and divide into discussion sections.
4. For joint subjects, figures are given for the subject number under which students enrolled.
5. HASS-D Language Option subjects (Level III or IV languages) are included in the HASS-D figures.

* Music and Theater Arts six-unit performance subjects are not included in these statistics.

Table 2. Concentrations in All Fields of the Humanities, Arts, and Social Science*, June 2001

Fields of Concentration	Class of 2004		Class of 2003		Class of 2002		Class of 2001		Totals in Fields	
American Studies	(0)	0	(3)	0	(1)	1	(4)	3	(8)	4
Ancient and Medieval Studies	(1)	0	(2)	0	(8)	1	(3)	3	(14)	4
Anthropology	(0)	0	(7)	0	(17)	4	(32)	30	(56)	34
Archaeology	(0)	0	(5)	1	(8)	2	(5)	4	(18)	7
Black Studies	(0)	0	(0)	0	(1)	0	(2)	2	(3)	2
Comparative Media Studies	(0)	0	(9)	0	(22)	2	(14)	13	(45)	15
Constitutional Tradition	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
East Asian Studies	(0)	0	(20)	1	(12)	4	(22)	22	(54)	27
Economics	(1)	0	(120)	5	(169)	38	(314)	298	(604)	341
Ethnic Studies	(0)	0	(0)	0	(1)	0	(0)	0	(1)	0
Foreign Languages**	(3)	1	(92)	2	(129)	28	(190)	182	(414)	213
History	(0)	0	(12)	0	(26)	4	(43)	40	(81)	44
History of Art and Architecture	(0)	0	(3)	0	(6)	0	(6)	6	(15)	6
Labor in Industrial Society	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
Latin American Studies	(0)	0	(1)	0	(2)	0	(7)	7	(10)	7
Linguistics	(0)	0	(7)	0	(4)	0	(10)	9	(21)	9
Literature	(0)	0	(26)	0	(41)	9	(71)	68	(138)	77
Middle Eastern Studies	(0)	0	(1)	0	(3)	0	(2)	1	(6)	1
Music	(0)	0	(25)	2	(47)	6	(92)	86	(164)	94
Philosophy	(0)	0	(18)	1	(14)	3	(54)	51	(86)	55
Political Science	(0)	0	(17)	0	(24)	5	(39)	35	(80)	40
Psychology	(0)	0	(11)	0	(18)	3	(49)	47	(78)	50
Religion	(0)	0	(0)	0	(1)	0	(1)	1	(2)	1
Russian Studies	(0)	0	(0)	0	(0)	0	(1)	1	(1)	1
Science, Technology, and Society	(0)	0	(8)	1	(10)	1	(25)	25	(43)	27
Theater Arts	(0)	0	(9)	0	(15)	2	(28)	25	(52)	27
Urban Studies	(0)	0	(8)	0	(9)	1	(15)	13	(32)	14
Visual Arts and Design	(0)	0	(2)	0	(3)	0	(13)	10	(18)	10
Women's Studies	(0)	0	(4)	0	(8)	3	(14)	13	(26)	16
Writing	(0)	0	(17)	0	(32)	1	(60)	53	(109)	54
Special Concentrations	(0)	0	(2)	0	(0)	0	(3)	3	(5)	3
TOTAL	**(5)**	**1**	**(429)**	**13**	**(631)**	**118**	**(1119)**	**1051**	**(2184)**	**1183**

* The parenthetic figure is the number of proposed concentrations in the given class and field; the figure to its right is the number of these concentrations that have been completed.

** Figures for subfields of Foreign Languages and Literatures are below:

Chinese	(0)	0	(17)	0	(17)	3	(26)	26	(60)	29
ESL	(0)	0	(0)	0	(2)	0	(0)	0	(2)	0
Theory of Language	(0)	0	(0)	0	(2)	1	(0)	0	(2)	1
French	(0)	0	(14)	0	(21)	3	(35)	34	(70)	37
German	(0)	0	(10)	0	(20)	8	(19)	18	(49)	26
Int'l Literature and Cultures	(0)	0	(0)	0	(0)	0	(5)	5	(5)	5
Japanese	(2)	0	(16)	0	(17)	5	(35)	34	(70)	39
Other Languages	(1)	1	(5)	0	(7)	0	(8)	7	(21)	8
Russian	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0
Spanish	(0)	0	(30)	2	(43)	8	(62)	58	(135)	68
Totals	**(3)**	**1**	**(92)**	**2**	**(129)**	**28**	**(190)**	**182**	**(414)**	**213**

Table 3. Undergraduate Majors

Year	Economics	Humanities*	Linguistics and Philosophy	Political Science	Total
1991–92	81	75	12	35	203
1992–93	75	64	5	41	185
1993–94	79	58	5	38	180
1994–95	81	56	8	40	185
1995–96	101	49	6	19	175
1996–97	99	31	8	31	169
1997–98	111	41	12	30	194
1998–99	91	55	6	18	170
1999–00	93	29	14	15	146
2000–01	84	25	10	16	135

*These figures do not include double majors who registered first in a course other than Humanities. (If you include double majors, the figure is 65 for Academic Year 2000–2001.)

Table 4. Graduate Students

Year	Economics	Hist and Soc Study of Sci and Tech	Linguistics and Philosophy	Political Science	*Comparative Media Studies	Total
1991–92	139	17	53	160		369
1992–93	149	21	57	154		381
1993–94	143	24	50	138		355
1994–95	130	29	65	122		346
1995–96	138	27	63	107		335
1996–97	132	28	68	123		351
1997–98	122	31	65	120		338
1998–99	121	33	69	116		339
1999–00	129	31	68	90	5	323
2000–01	134	26	70	99	13	342

*Comparative Media Studies (CMS)—1999–2000 was the first year of the new graduate program.

Table 5. Minor Applicants for the Classes of 2001–2004

Minor Field	Total Applications
Ancient and Medieval Studies	3
Anthropology	6
Comparative Media Studies	7
Economics	168
Foreign Languages	
French	7
German	16
Spanish	21
History	11
History of Art and Architecture	5
Linguistics	7
Literature	22
Music	47
Philosophy	6
Political Science	23
Public Policy	11
Psychology	13
Regional Studies Minor Programs	
African and African Diaspora	1
East Asian Studies	14
European Studies	2
Latin American Studies	0
Middle Eastern Studies	0
Russian Studies	1
Science, Technology, and Society	1
Theater Arts	12
Urban Studies and Planning	3
Women's Studies	3
Writing	29
Total Minor Applications	**439**

DEPARTMENT OF ECONOMICS

We are currently ranked as the best economics department in the world. Our goal is to make sure we stay there.

At the celebration of the School of Humanities, Arts, and Social Sciences 50th anniversary held at the Museum of Fine Arts on October 9th, President Vest announced that $75 million of Kenan Sahin's $100 million donation to MIT will be used to establish a Kenan Sahin Fund for the school. Of this $20 million has been earmarked for use in building the Economics department space within the new Sloan complex currently being planned.

Several department graduates received important honors. In April 2001, Matthew Rabin (Ph.D. '89) was awarded the John Bates Clark medal of the American Economic Association. This award is presented every other year to an outstanding economist under the age of 40. It was the sixth such award to an alumnus of the MIT Economics department.

Graduates of the MIT Economics Department continued to play an important role in higher education. Lawrence Summers (EC '75) was named the President of Harvard University and Lawrence Bacow (SB '72) was named the President of Tufts University.

A number of faculty members were nominated or elected to leadership positions in various economics associations. Institute Professor Peter Diamond was chosen as the President-elect of the American Economic Association and Professor James Poterba was elected to the executive committee. Professor Olivier Blanchard was elected to the Council of the Econometric Society. Professor Peter Temin was President of the Eastern Economic Association.

A number of faculty and students have received important honors and awards. Assistant Professor Esther Duflo received an Olin Faculty Fellowship. Assistant Professor Sendhil Mullainathan received a Sloan Foundation Research Fellowship. Professor Temin received a Guggenheim fellowship. One of our graduate students, Emek Basker, won the MIT Graduate Student Council teaching award for the School of Humanities, Arts, and Social Sciences.

EDUCATION

Next year's entering class of 24 Ph.D. students will include 14 international students and 8 women (33 percent). Seven of our entering class have National Science Foundation Fellowships.

Undergraduate enrollment decreased this year by 7 percent. This is a dip on a clear positive trend in enrollment. The increase is of nearly 65 percent over the last fifteen years.

There were 118 undergraduate majors in economics (34 of whom are double majors), 151 undergraduate minors, and 367 concentrations completed in economics. 41 students received their S.B. in economics in 2001.

Our graduate students on the job market did well this year, with 28 percent receiving assistant professorships in top 20 economics departments and business schools. A total of 71 percent accepted academic positions, 14 percent took positions in government, and 14 percent obtained positions in the private sector.

The World Economy Laboratory (WEL), directed by Professor Rudiger Dornbusch, continued to provide resources for the department. Two WEL conferences were held in Washington DC during the academic year.

FUTURE PLANS

Our department is doing very well. The atmosphere is warm and friendly, the research atmosphere is exciting, and faculty members are productive. Our junior faculty are particularly outstanding, and we see this as our main strength for the future. Some fields where we were less strong, labor economics and development in particular, are expanding and attracting an increasing number of students. A new field, behavioral economics, is becoming increasingly popular.

We feel we still have two major senior needs, one in theory and one in macroeconomics. We had two search committees looking at potential candidates. We made an offer in theory to Paul Milgrom, who has decided to visit the department and decide during the coming academic year. We did not make an offer in macroeconomics, but have invited a number of senior researchers to visit us over the next few years; these visits may lead to offers in due time.

Competition from other departments is becoming more intense, and our few competitors are often bigger and richer. We strongly feel that, to thrive in the long run, the department must increase in size, both by expanding its core, and the number of faculty members in major fields. We made the case to the visiting committee this spring, and later to the senior administration. We are happy with their response, and hope to be able to make progress along these lines over the next few years. We also have to secure one of our main assets, the quality of our student pool, by increasing the number of fellowships we can offer. This is all the more urgent, given the decline in many of the traditional external sources of such fellowships.

PERSONNEL

Professors David Autor, Esther Duflo, and Xavier Gabaix were reappointed as Assistant Professors.

George Marios Angeletos will join the faculty as an Assistant Professor as of July 1, 2001. He received his Ph.D. from Harvard University and is a macroeconomist.

Associate Professor Susan Athey resigned effective June 30, 2001. She will assume a position in the Economics Department at Stanford University.

There were eleven visiting faculty for all or part of the 2000–2001 academic year. Visiting Professor Jean Tirole taught a topics course in industrial organization. Visiting Professor Roger Brinner taught macroeconomics. Visiting Professor Mathias Dewatripont taught microtheory. Visiting Professor Thomas Piketty taught public economics. Visiting Professor Robert Barro taught growth economics. Visiting Professor Kevin Lang taught labor economics. Visiting Professor Wallace Mullin taught microtheory and industrial organization. Visiting Professor Robert Rosenthal taught game theory. Visiting Professor Christopher Snyder taught microeconomics. Visiting Professor Nobuhiro Kiyotaki taught macroeconomic theory. Visiting Professor Robert Townsend taught development economics.

The department would like to increase the proportion of women and minorities in the department. All search committees are instructed to identify outstanding women and minority candidates as part of their search process. As part of the regular recruitment process for junior faculty, the department solicited/received 206 CVs. Nineteen candidates (including four women) were selected for interviews. All candidates were interviewed by at least two members of the faculty. Subsequently, two candidates, both male, were invited to come to MIT and present a seminar. As a result of this process, one offer was made to George Marios Angeletos.

HONORS AND AWARDS

Professor Joshua D. Angrist was appointed to the editorial board of the *American Economic Review.*

Professor Athey received the Elaine Bennett Research Award, 2001 which is awarded every other year based on research to a young woman in any area of economics. She was named the Hoover Institution National Fellow, 2000–2001, as well as the Sloan Foundation Research Fellow, 2000–2002. She was appointed as an Associate editor of both the Quarterly Journal of Economics, 2001 and the BE Press Journal of Theoretical Economics, 2000. She was appointed a Co-Organizer of the NBER Industrial Organization Program Meetings, Winter 2001, and she was named an NBER, Research Associate, 2001.

Professor Autor received First Prize, Milken Institute Award for Distinguished Economic Research, "The Contribution of Unjust Dismissal Doctrine to the Growth of Employment Outsourcing." He also received the Steven H. Sandell Grant for Junior Scholars in Retirement Research

Professor Abhijit Vinayak Banerjee was an Invited Speaker at the Economic Society World Congress and also at the Games 2000.

Professor Blanchard was an invited speaker at the Lionel Robbins lectures given at the London School of Economics in 2000, and he gave the Wellington-Burnham lecture at Tufts University in 2001. He was elected to the Econometric Society Council in 2001, and was nominated to a number of Advisory Boards including the International Advisory Board to the NES in Moscow in 2000, and the Advisory Boards for the IFO in Munich in 2000, the Portuguese Economic Journal in 2000,and the Journal of Money, Credit, and Banking in 2001. He was nominated to be a Research fellow at the IZA, University of Bonn in 2001.

Assistant Professor Victor Chernozhukov received an Alfred P. Sloan Doctoral Dissertation Fellow, 1999–2000

Associate Professor Dora L. Costa Received the Economic History Association's Alice Hanson Jones Book Prize, 2000 for *The Evolution of Retirement: An American Economic History*, 1888–1998.

Professor Diamond was nominated to be the President of the American Economic Association, 2002.

Professor Duflo received a NSF Fellowship "The Determinants of 401(k) Participation: The Role of Economic Incentives, Plan Design, Financial Education, and Learning". She also received the John M Olin Faculty Fellowship.

Professor Glenn Ellison was elected as Fellow of the Econometric Society.

Professor Franklin M. Fisher received the Ida Cordelia Beam, Distinguished Visiting Professorships Program, University of Iowa, 2001, and he received a Doctor Philosophiae Honoris Causa, Hebrew University of Jerusalem, 2001

Professor Bengt Holmstrom gave the Keynote address at the German Management Association Meetings, "Corporate restructuring: markets versus managers," Berlin, June 2000. He was the Woodward lecturer, University

of British Columbia, November 2000. He was a foreign member of The Swedish Royal Academy of Sciences, January 2001.

Professor Paul L. Joskow was elected Vice President of the International Society for Institutional Economics. He was also reappointed to the EPA Science Advisory Board.

Assistant Professor Guido M. Kuersteiner received NSF Grant No. SES-0095132: Small Sample Refinements of Moment Based Estimators.

Professor Poterba was elected to the Executive Committee of the American Economic Association, 2001–2003. He was also a George and Karen McCown Distinguished Visiting Fellow at the Hoover Institution, 2000–2001.

Professor Nancy L. Rose was a George and Karen McCown Distinguished Visiting Fellow at the Hoover Institution. She was also named a member of the program Committee for Econometric Society 2002 North American Winter Meetings.

Professor Temin received a Guggenheim Fellowship for 2001–2002 and was President of the Eastern Economic Association.

Associate Professor Jaume Ventura received the MIT Graduate Economics Association "Best Teacher" Award, 2000–2001. He was also a member of the editorial board at both the Bepress *Journals in Macroeconomics* and the journal *Moneda y Credito.*

RESEARCH ACHIEVEMENTS
Faculty research includes:

Professor Angrist's paper "Consequences of Employment Protection? The Case of the Americans with Disabilities Act," written with Professor Daron Acemoglu, is forthcoming in the *Journal of Political Economy.*

Professor Athey's paper "Information and Competition in Timber Auctions," written with Jonathan Levin, was published in the *Journal of Political Economy.*

Professor Autor's article "Wiring the Labor Market." Was published in the *Journal of Economic Perspectives.*

Professor Banerjee's paper "A Simple Model of Voice", written with Rohini Somanthan, appeared in the *Quarterly Journal of Economics.*

Professor Blanchard's paper "What do we Know about Macroeconomics that Fisher and Wicksell did not?" appeared in both the *Quarterly Journal of Economics* and in *De Economist.*

Professor Ricardo Caballero's paper "Macroeconomic Volatility in Latin America: A Conceptual Framework and Three Case Studies" was published in *Economia.*

Professor Chernozhukov's paper "Conditional Value at Risk: Aspects of Modeling and Estimation" written jointly with L. Umantsev was published in *Empirical Economics.*

Professor Costa's paper "Power Couples: Changes in the Locational Choice of the College Educated, 1940–1990," a joint work with Matthew E. Kahn, was published in the *Quarterly Journal of Economics.*

Professor Dornbusch wrote "Robert A. Mundell's Memorial Prize," which appeared in *The Scandinavian Journal of Economics.*

Professor Duflo's paper "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment is forthcoming in the *American Economic Review.*

Professor Ellison's paper "Geographic Concentration as a Dynamic Process," is forthcoming in the *Review of Economics and Statistics.*

Senior Lecturer Sara Fisher Ellison's "Gradual Incorporation of Information: Pharmaceutical Stocks and the Evolution of Clinton's Healthcare Reform" written with Wallace Mullin was published in the *Journal of Law and Economics.*

Professor Fisher wrote "The Economics of Sports Leagues and the Relocation of Teams: The Case of the St. Louis Rams" with C. Maxwell and E. Schouten which appeared in the *Marquette Journal of Sports Law.*

Professor Gabaix's paper "Price Fluctuations, Market Activity, and Trading Volume" written with Plerou, Vasiliki, Parameswaran, Gopikrishnan, Luis.A. N. Amaral, H. Eugene Stanley appeared in *Quantitative Finance.*

Professor Jerry Hausman published his paper "Microeconomics" in the *Journal of Economics.*

Professor Holmstrom's paper "Corporate Governance and Merger activity in the U.S.: Making Sense of the 1980s and 1990s," written with Steven N. Kaplan, is forthcoming in the *Journal of Economic Perspectives.*

Professor Joskow's paper "Regulating the Electricity Sector in Latin America, Comments," was published in *Economia.*

Professor Kuersteiner's work "Efficient Instrumental Variables Estimation for Autoregressive Models with Conditionl Heterogeneity" is forthcoming *Econometric Theory.*

Professor Michael Piore's paper "Thirty Years Later: Internal Labor Markets, Flexibility and the New Economy" is forthcoming in the *Journal of Management and Governance.*

Professor Poterba published his paper "The Distribution of Payroll and Income Tax Burdens, 1979–1999," written with A. Mitrusi, in the *National Tax Journal.*

Professor Rose wrote "Empirical Analysis of Regulation" and "Political Economy of Regulation" for the forthcoming *International Encyclopedia of the Social and Behavioral Sciences.*

Assistant Professor David Spector's paper "Is it possible to redistribute the gains from trade using income taxation?" is forthcoming in the *Journal of International Economics.*

Professor Temin's "The Great Depression," was published in *The Cambridge Economic History of the United States.*

Professor Ventura's article "A Portfolio View of the U.S. Current Account Deficit," is forthcoming as a *Brookings Papers on Economic Activity.*

Professor William C. Wheaton published his article "Decentralized Welfare: Will there be Under Provision?" in the *Journal of Urban Economics.*

More information about the department can be found online at http://econ-www.mit.edu/.

Olivier Blanchard

ANTHROPOLOGY

The MIT Anthropology Program is dedicated to advanced research and publication in cultural anthropology; to undergraduate teaching that opens students to the fundamentals of cross-cultural understanding and social thought; and to graduate teaching in the history and social study of science and technology. Our undergraduate subjects cover a wide range, with special strengths in the study of the contemporary world and the social context of technology. The anthropology faculty maintains strong ties with other programs in the School of Engineering and the School of Humanities, Arts, and Social Science, including Women's Studies, Latin American Studies, Comparative Media Studies, the Technology Policy Program, the History Faculty, and Science, Technology, and Society.

PERSONNEL AND ADMINISTRATIVE CHANGES

In July of 2000, Professor Susan Slyomovics succeeded Professor James Howe as head of the Anthropology Program. During 2000–2001, Susan Silbey, Professor of Sociology at Wellesley College, accepted a position in the MIT Anthropology Program at the rank of Full Professor, beginning July 1, 2001. Professor Silbey, a sociologist with a strong background in legal scholarship and ethnographic research, specializes in socio-legal studies and anthropology of the law. A highly regarded educator, awarded a prize for excellence in teaching at Wellesley College, she has produced outstanding scholarly studies on the study of law as social practice, further strengthening and consolidating our curriculum. Also, during 2000–2001, the reorganization of the Anthropology Program including the administrative separation from the Science, Technology and Society Program, was approved. This is to take effect as of July 1, 2001, with Rosemary Hegg serving as Program Administrator.

PROGRAM CONTRIBUTIONS TO THE MIT AND OUTSIDE COMMUNITIES

The committees, boards, and task forces at MIT on which Anthropology Program members served this year include the Women's Studies Steering Committee, the Gender Equity Committee, the Kelly-Douglas Prize Committee, the Knight Fellowship Selection Committee, the admissions committee for CMS, and the steering committee of the doctoral program in the History and Social Study of Science and Technology (HSSST).

Professors Michael Fischer, Jean Jackson, and Howe, and Associate Professor Hugh Gusterson all play active roles in teaching, advising, and administration of the HSSST doctoral program, sponsored by the STS, History, and Anthropology Programs. Professor Arthur Steinberg continues as director of the Integrated Studies Program.

Outside MIT, Professor Jackson is on the advisory board of Cultural Survival and the editorial board of the Journal of Latin American Anthropology. Professor Slyomovics serves on seven boards. Professor Howe is President of the non-profit organization, Eagle Light Caretakers. Professor Gusterson was the Program Chair of the Society for Social Studies of Science (4S) Meeting 2001. He also serves on five other committees. Assistant Professor Christine Walley has worked on a range of projects with community development organizations on Mafia island in Tanzania (while doing follow up research on environmental issues) including the creation of a fund-raising video for a women's group.

PRESENTATIONS

In October 2000, Professor Slyomovics spoke about vernacular architecture at the International Workshop on the Reconstruction of Architectural Heritage, in Prishtina, Kosovo. Professor Walley presented a paper entitled "'Burying' Development in the Ground: Alternative Understanding of Progress within the Mafia Island Marine Park, Tanzania" at the American Anthropological Association meetings, San Francisco, 2000. Professor Howe gave a talk at the AAA Meetings in November 2000 entitled "The Art of Collaboration: A Happy Case Study." Professor Jackson's paper, "Colombia's Amazonian Indigenous Communities and the Civil War," was presented at the Conference on Indigenous Amazonia at the Millennium: Politics and Religion, at Tulane University, in January 2001. Professor Jackson has also given talks in Leipzig and Montreal. Professor Gusterson gave a number of talks on the Wen Ho Lee case and on the controversy over genetically-modified food.

PUBLICATIONS

Professor Slyomovics' coedited volume, *Women and Power in the Middle East*, was published by University of Pennsylvania Press, and a second edited volume, *The Living Medina in the Maghrib*, is in press. Professor Jackson's coedited volume, *Indigenous Movements, Self-Representation and the State in Latin America*, is in press at University of Texas Press. Professor Gusterson's edited volume, *Securityscapes: An Anthropologist Encounters the Nuclear Complex* is under contract with University of Minnesota Press. His article "The Virtual Nuclear Weapon's Laboratory in the New World Order" appeared in *American Ethnologist 2 (1)*, 2001. Professor Howe published an article during 2001 entitled "The Kuna of Panama" in *Endangered Peoples of Latin America: Struggles to Survive and Thrive*, Westport CT: Greenwood Press. Professor Howe's book, *A People Who Would Not Kneel*, is being translated into Spanish, to be published next year by CIRMA, in Guatemala. Professor Walley's article "'They Scorn Us Because We are Uneducated': Science, Popular Knowledge and Power within the Mafia Island Marine Park, Tanzania", has been accepted for publication in a special issue of *Anthropological Quarterly*.

More information on the Anthropology Program can be found online at http://web.mit.edu/anthropology/www/.

Susan Slyomovics

FOREIGN LANGUAGES AND LITERATURES

Foreign Languages and Literatures (FL&L) is dedicated to providing MIT students with the tools for a sensitive and successful involvement in the global community by contributing to the internationalization of their MIT education. During the academic year 2000–2001, FL&L faculty continued to provide national and international leadership in the fields of foreign language pedagogy, technology in the humanities, and literary and cultural studies, while demonstrating their commitment to educational excellence within the Institute.

HIGHLIGHTS OF THE YEAR

Professor Jing Wang, formerly Director for the Center for East Asian Institutional and Cultural Studies at Duke University, has been appointed the S.C. Fang Professor in Chinese Language and Culture in FL&L beginning July 2001; Lecturer in English Language Studies (ELS) Jane Dunphy is being named Director of ELS beginning July 2001, and Professor of French Studies Isabelle de Courtivron continues as Section Head. Several members of the section were recognized in their fields: Professor of Japanese and Linguistics Shigeru Miyagawa was invited to participate on the committee which launched the MIT Open Courseware Initiative; Professor of French Studies and Film, Edward Baron Turk was Film Editor for *The French Review*; Visiting Associate Professor of French Odile Cazenave received the Choice Outstanding Academic Award for her book entitled *Rebellious Women: The New Generation of Female African Novelists*; Assistant Professor of Chinese Emma Teng received the J. Paul Getty Postdoctoral Fellowship Award for 2000–2001; Senior Lecturer in Spanish Douglas Morgenstern served as an MIT Representative to the Governing Board for the Consortium for Language Teaching and Learning and presided over the Open Forum on Distance Learning at the Modern Language Association (MLA) Annual Convention in Washington, D.C.; Lecturer in French Sabine Levet was named President of the American Council on the Teaching of Foreign Languages (ACTFL) Special Interest Group on the Teaching and Learning of Culture for 2000–2001. Associate Professor of Hispanic Studies Margery Resnick continued as President of the International Institute in Spain and has also just completed her third year as Chair of the Program in Women's Studies. Professor Miyagawa was on leave during the Fall 2000 semester; Professor of Linguistics and Second Language Acquisition Suzanne Flynn was on leave during the Academic Year 2000–2001.

AWARDS AND GRANTS

FL&L faculty and lecturers continue to receive awards, grants, and funding with which to develop materials and new technology to enhance the teaching of foreign languages, literatures, and culture. Professor de Courtivron and the Center for Bilingual/Bicultural Studies received the John S. and James L. Knight Foundation award to fund Short Term Residencies for International Writers. She was also awarded the Provost Fund for compiling and co-editing *Contemporary French Feminisms, a collection of essays on contemporary French Women.* Professor of Comparative Media Studies William Uricchio received a grant from the European Science Foundation for his book *Changing Media, Changing European Identity*. Professor Miyagawa received funding from Fuji-Xerox for his research on issues concerning Japanese document structure, the Distinguished Award from Multimedia Grandprix 2000 (Japan) for his StarFestival Network, the highest rating from the International Society of Technology Educators for StarFestival Multimedia Curriculum, and a grant from the Institute of Turkish Studies for an international conference on Altaic Linguistics. Professor Miyagawa and Senior Lecturer Morgenstern both received class awards from Class of 51/55/57; Professor Miyagawa for his Moon Festival project and Professor Morgenstern for his Valencia project. Research Associate Kurt Fendt (with Professor of Literature Henry Jenkins, CMS) received the MIT d'Arbeloff Fund for MetaMedia, a multimedia framework for enhancing media literacy and communication skills. He also was awarded a Research Fellowship from the German National Research Center for Information Technology (GMD), in St. Augustin, Germany, for research on multimedia learning environments. Senior Lecturer in German Ellen Crocker, Senior Lecturer in French Gilberte Furstenberg, Lecturer Dunphy, and Research Associate Fendt received funding from DaimlerChrysler to develop a prototype for training modules for cross-cultural corporate communication.

The Consortium for Language Teaching and Learning remains a strong supporter of FL&L multimedia projects. The Consortium provides annual funding to each member institution (campus-based projects) and awards funding on a competitive basis for its members (consortial projects). This year's sole recipient of the consortial-project funding was Berliner sehen Exchange, a shared on-line teachers manual, student workbook and educators forum (co-PIs, Research Associate Fendt and Senior Lecture Crocker). In addition to funding from the Marion and Jasper Whiting Foundation, Senior Lecturer Furstenberg received campus-based Consortium funding for further development of "Cultura," a web-based tool for developing cross-cultural understanding. Consortium support was also given for Lecturers in Japanese Keiko Iijima's and Yoshimi Nagaya's project entitled "Advanced Readings and Communication in Japanese," Lecturer in French Johann Sadock's second phase of his project "Au-delà du regard: recontres multiethniques," a web-based module that focuses on the changing face of French society as a result of an increasingly racially and ethnically diverse youth, and Lecturers in Spanish Adriana Gutiérrez-González's and Margarita Ribas Groeger's project, "Immigrant Voices: Stories from Hispanic Communities in Boston."

RESEARCH AND PUBLICATIONS

Research in the areas of literary and cultural studies, linguistics and language pedagogy continues to be of the highest caliber and is regularly published in internationally respected journals. Professor Turk's Book, *Child of Paradise* (Harvard University Press, 1989) is being translated into French for publication in Paris next winter. Professor Miyagawa wrote "The EPP, Scrambling, and Wh-in-situ," which appeared in *Ken Hale: Life in Language.*

Professor Uricchio completed *Televisuality...In Particular German Developments, 1928–1945* for Cambridge University Press and *Early Cinema and Social Space* for the University of California Press. He also had his work included in two books: "*La formazione dei pubblici*" appeared in *Storio del Cinema 1.*, "*Filmvoführer in New York, 1906–1913*," co-authored with R. E. Pearson which was included in *KINtop: Jahrbuch zur Erforschung des frühen Films 9.* Professor Teng wrote "*Miscegenation and the Critique of Patriarchy in Turn-of-the-Century Fiction*," which appeared as a chapter in *Asian American Studies: A Reader.* Visiting Associate Professor Cazenave's chapter "Writing New Identities: the African Diaspora in France" was included in *Literature of Immigration In France* and "Vingt ans après Mariama Bâ, nouvelles écritures au féminin" appeared in the Journal, *Africultures 34 and 35.* Lecturer in German Bernd Widdig's book *Culture and Inflation in Weimar Germany* was published by the University of California Press. Research Associate Fendt wrote "Die koh renz des Nicht-Linearen: ber den Erwerb Komplexen Wissens in Hypertextsystemen," which appeared in *Medien, Texte und Maschinen. Angewandte Mediensemiotik,* and "Contextualizing Content: The Potential of Hypermedia for Interdisciplinary Language Learning," which appeared in *Language Across the Curriculum: Interdisciplinary Structures and Internationalized Education.* Senior Lecturer Furstenberg and Lecturer Levet (along with Katherine Maillet and Kathryn English) wrote an electronic article for the January 2001 Language Learning and Technology Journal entitled "Giving a Virtual Voice to the Silent Language of Culture, or Developing Cross-Cultural Literacy Via the Web: the Cultura Project http://llt.msu.edu/vol5num1/furstenberg/default.html."

SECTION HIGHLIGHTS

This year, FL&L's Center for Bilingual/Bicultural Studies (CBBS) in association with the Program in Women's Studies brought distinguished filmmaker Tsitsi Dangarembga to MIT as a Visiting Lecturer in residence for a semester. She taught the class entitled Topics in Global Culture and helped Professors Cazenave and Resnick host a successful three-day conference on African women writers and filmmakers, co-sponsored with the Program in Women's Studies. Her works include the film "Everyone's Child" as well as the book *Nervous Conditions: A Novel.* FL&L also sponsored talks by noted authors Holger Teschke, José F. A. Oliver, André Aciman, Eric Fassin, and Dr. Guy de Teramond, Minister of Science and Technology for Costa Rica.

CONFERENCES AND PRESENTATIONS

FL&L faculty were invited to numerous national and international conferences. Professor de Courtivron was an invited speaker at University of California at Berkeley on "Colette and the Art of Paradox," and at Georgetown on "Language Policy, Poletics, and Polemies in Contemporary France." The Sarasota Institute of Life-Long Learning invited her to speak on "The Impact of Globalization on Language, Culture and Identity." Professor of Spanish and Latin American Studies Elizabeth Garrels presented the paper "La necrofilia bolitica, o la lucha por el cuerpo muerto de Facundo" at the conference of the 23rd International Congress of Iberamerican Literature, University of Salamanca, Spain. Professor Miyagawa was an invited speaker at the Japan-America Institute of Management Science on "Jazz, Race, and Identity." He presented the StarFestival Network to the National Cable Industry Representatives (CNN, Time-Warner, Disney, AT&T, Fox, Discovery, Comcast, Cable in the Classroom) in Washington, D.C. At Bhosphorus University in Istanbul he gave two workshops on Word Order and Altaic Languages. He was on the organizing committee for the conference entitled "Formal Approaches to Japanese Linguistics 3," and presented a paper on "Japanese, Korean, and Turkish," at the Workshop on Altaic Languages here at MIT. In addition, he gave a talk entitled, "Technology and Education in the 21st Century" in Saga Japan. Professor Turk presented a paper called "Boy Bands and Girl Singers," at the MIT Communications Forum on Performance and Theatricality. Professor Uricchio was organizer for two European Science Foundation research group meetings, in Palermo and Paris. Professor Teng was the invited speaker at several conferences: the International Conference on the Plains Aborigines in Taiwan, "The Raw and the Cooked: Images of Taiwan's Indigenous People in Literature and Illustrations," "Beardless Men and Big-Footed Women: Visualizing Gender and Ethnicity in Representations of Frontier Peoples in the Qing Imperial Tribute Illustrations," at the New Directions in Chinese Women's and Gender History Conference at Columbia University. She also spoke at the International Crossroads for Cultural Studies Conference in Birmingham England, the International Conference on Art, Literature and Travel in Taiwan, and the Association for Asian American Studies Conference in Arizona. At the American Council on the Teaching of Foreign Languages (ACTFL) Senior Lecturer Morgenstern co-presented with Lecturers in Spanish Gutiérrez-González and Groeger "Experiential Learning: Designing Classroom and Computer-Assisted Activities For Spanish," Senior Lecture Julian Wheatley was a discussant (in Chinese) on a panel on "Literacy Instruction in China" at the Chinese Language Teachers Association Conference (CLTA/ACTFL), and Senior Lecturer Crocker, Lecturer Gutiérrez-González and Lecturer Groeger gave a joint panel presentation called "The Internet, National Standards and Cultural Diversity: Understanding Other Cultures." Senior Lecturer Furstenberg presented a paper entitled "From the Blackboard to the World Wide Web and Back: Methodological Connections, Transformations and Reflections," and with Lecturer Levet presented a paper entitled "Developing Students' Understanding of a Foreign Culture: a priority for the 21st Century." Senior Lecturer Furstenberg also gave a presentation of the Cultura project at UCLA, The University of California at Santa Barbara, The University of California at San Diego, Princeton University, Harvard University as well as to the MISTI group here at MIT, and presented papers to CALICO (Computer Aided Language Instruction Consortium), and the Association of Departments of Foreign Languages (ADFL) at the Modern Language Association Meeting in Washington, D.C. Senior Lecturer Wheatley was on the panel "Advanced Beginners" at a Conference at Brown, spoke on "Ritual Language" at a Burma Studies Conference, conducted a workshop on language teaching at Princeton University, and was a panelist on "Professionalization of Southeast Asian Language Teaching" at the Association of Asian Studies Conference in Chicago. Senior Lecturer Crocker presented "Exploring Cultures-The Potential of Multimedia for

Collaborative Learning" and held a workshop entitled "Integrating Interactive Media into the Foreign Language and Culture Curriculum: French, German, Spanish" at the Vassar-Williams Mellon Consortium at Williams College. Lecturer Dunphy conducted a Seminar at Woods Hole Oceanographic Institute on "The Art of Writing a Scientific Abstract," at Kennedy School of Government at Harvard University on "Interacting Across Cultures: Considerations in Using English in the European Union," and at International Tesol, St. Louis on "Weaving Authenticity Into the Pre-MBA Program." Visiting Associate Professor Cazenave conducted several panel sessions of which she was Chair and Moderator: Two sessions at the African Literature Association Conference in Richmond Virginia in April; four literary cafés with African writers, and a session with filmmakers. She was a panelist at Brown University for "Lumumba and Mobutu: African Cinema" and gave a talk at Harvard University entitled "Vingt ans après Mariama Bâ nouvelles écritures postcoloniales en France." Lecturer Levet was invited to conduct two workshops on "Bringing Culture to the Forefront of the Foreign Language Class: the Role of Technology" at Emory University and Bard College. She also presented at the CALICO conference: "Instructional Design of Classroom Strategies for Web-based Cross-Cultural Learning" (with Katherine Maillet, INT France), "The Cultura Project: In the Language Class and Beyond" at (CAES) the Center for Advanced Educational Technology and Athenium at MIT, and "Integrating Pedagogy and Technology" at NERALLD Conference of Language Lab Directors at MIT on how to help faculty integrate technology in their teaching. Lecturer Groeger conducted a workshop called "Tacit Assumptions and the Potential of Language Instruction" at the Consortium for Language Teaching and Learning Governing Board Annual Meeting at Harvard University. Lecturer in Chinese Tong Chen presented a paper at the International Conference on Teaching Chinese to Foreigners in Wuhan, China. Lecturer in ELS Patricia Brennecke conducted a workshop called "Culture and Teaching" at The American School in Switzerland. Lecturer Sadock presented a paper "Beyond Fiction in Film and in Documentaries: the Impact of the Internet on the Teaching of French Cultural Diversity" at the International Conference at La Sorbonne in Paris. Lecturer in ELS Mary Christie presented a paper entitled, "Increasing Comprehensibility Among Non-Native Speakers When English Is The Lingua Franca," at the Association For Business Communication European Convention 2001. Lecturer Widdig was invited to speak at Universität Müchen in Munich, the Third International Colloquium on International Engineering Education at the University of Rhode Island, and the Consortium on Financing Higher Education Assembly Meeting at Wesleyan University where his talk was entitled "Internationalizing Education at MIT."

PROGRAMS AT MIT

Faculty and lecturers also participated in programs organized at MIT. Professor Turk was a Faculty Advisor for the International Film Club. Professor Uricchio gave an MIT webcast lecture entitled, "Globalization and Media Convergence." Senior Lecturer Furstenberg gave presentations of her three French multimedia programs: "A la Rencontre de Phillippe," "Dans un Quartier de Paris" and "Cultura" for MacVicar Day, on the topic: "Can Technology Transform the Way You Learn Japanese and French?" Senior Lecturer Morgenstern organized a day-long session of Sine Nomine on Representation and Teaching of Culture in the Language Class at MIT with Professor Miyagawa and Lecturer Levet as panelists. Senior Lecturer Morgenstern was also project director for MITUPV Exchange Distance learning website in Spanish and English for students of MIT and Universidad Politècnica de Valencia, Spain; in collaboration with 6.916 Software Engineering of Innovative Web Services (Profs. Hal Abelson and Philip Greenspun). Senior Lecturer Wheatley was the Director of MISTI China, Senior Lecturer Furstenberg acted as liaison between the French group in FL&L and the MIT-France Program, Lecturer Widdig was Director of the MIT-Germany Program and acting Program Manager for the Global Venture Creation Network at the MIT-Entrepreneurship Center. Senior Lecturer Crocker organized an event, Fernlautmetz German-Spanish Poetry Reading and Musical Performance with German Poet José F.A. Oliver. Visiting Associate Professor Cazenave set the program for the MIT African Film Series in February 2000. She was also co-organizer for MIT African Week where she participated in the roundtable "Bilingual, Bi-Cultural Identity and Creativity In Contemporary Africa," translated for writers in the roundtable "Whose Human Rights?" and moderated the roundtable "Gender and Human Rights in Africa Through The Arts" with Véronique Tadjo (Ivory Coast), Monique Ilboudo (Burkina Faso), Tsitsi Dangarembga (Zimbabwe) and Anne-Laure Folly (Togo) which was sponsored by FL&L and Women's Studies. Lecturer Dunphy was a consultant in ELS Curriculum Design for the Singapore MIT Alliance, (SMA).

MIT SERVICE AND ENROLLMENTS

Members of the FL&L faculty also contribute to MIT through their service on a number of Institute-wide committees: The Academic Computing Strategic Planning Committee, The Committee for Undergraduate Policy, the Burchard Scholars, the Women's Studies Steering Committee, CMS Steering Committee, CMS Graduate Admissions Committee, Life-Long Learning Committee, Subcommittee on the Undergraduate Communication Requirement among others. Associate Professor Resnick was particularly active on several MIT committees and projects this past year. She served on the committee on the Library System 2000–2001 which formulates policy for the administration of the libraries; ran the AMITA-funded "Women at MIT" program, headed the Burchard Scholars program, was Director of the MacVicar/Oral Histories of MIT Women Graduates, and ran the MIT/University of Muenster online course.

FL&L has maintained its commitment to making full-time appointments and to attracting qualified candidates from minority groups. In order to achieve these goals, FL&L has targeted historically black colleges and universities and has advertised in journals and association web sites focusing on the minority community. We currently have several members of our full-time faculty and full and part-time teaching staff who are under-represented minorities or women.

While the number of majors in FL&L remains low at three, the number of minors (68) and the number of concentrators (521) has remained relatively stable. Spanish continues to have the largest enrollments at 575; followed by English Language Studies, 360; French, 245; Chinese, 242; Japanese, 239, German, 181, and Italian, 80. Enrollments in Studies in International Literatures and Cultures (cross-cultural language and culture subjects taught in English) are subsumed under the language group to which the instructor belongs.

More information about this section can be found online at http://web.mit.edu/fll/www/.

Isabelle de Courtivron

HISTORY

The mission of the History faculty is to promote advanced research and undergraduate teaching in a broad range of fields, including American, Ancient, East Asian, European, Latin American, Middle Eastern, and Russian history. The faculty includes joint appointments in Urban Studies, in Writing, and in Science, Technology, and Society, and it participates in the joint Ph.D. program in the History and Social Study of Science and Technology.

Professor John Dower's *Embracing Defeat: Japan in the Wake of World War II* continued to receive numerous honors including the PEN/New England L.L. Winship Award for the year's best book with a New England author, the Mark Lynton History Prize from Harvard, and an American Library Association Notable Book award. Associate Professor Jeffrey Ravel's *The Contested Parterre: Public Theater and French Political Culture, 1680-1791* won the Barnard Hewitt Award for best book on Theater History, awarded by the American Society for Theater Research. Professor Harriet Ritvo published several articles, including "The Natural World," which appeared in *The Victorian Vision: Inventing New Britain* and "Animal Consciousness: Some Historical Perspective," in *The American Zoologist*. Professor Peter Perdue published, "Culture, History, and Imperial Chinese Strategy," in *Warfare in Chinese History*. Associate Professor Elizabeth Wood published, "The Trial of Lenin: Legitimating the Revolution Through Political Theater," in *The Russian Review*. Associate Professor William Watson published "Learning from Carlos: Ernest Hemingway the Apprentice Fisherman," in *The North Dakota Quarterly*. Assistant Professor Joshua Sosin published articles "Agio at Delphi" in *The Numismatic Chronicle* and "Ausonius' Juvenal and the Winstedt Fragment" in *Classical Philology*. Professor Bruce Mazlish published "The Art of Reviewing" in *Perspectives*. Professor Philip Khoury published "Current Developments and Future Directions in Middle Eastern Studies" in *Frontiers: The Inter-disciplinary Journal of Study Abroad*. Professor Pauline Maier has completed the first eight chapters of an innovative American History textbook that incorporates the history of science and technology. This project received funding from the Sloan Foundation. Professor Merritt Roe Smith is the project's director; the other authors are Alex Keyssar of Duke University and Daniel Kevles of Yale.

Professor Mazlish presented a paper on "A Global Elite?" at the New Global History Faculty seminar. Professor Perdue spoke on "China and Russia: Backing into The Future" at Haverford College. Professor Ritvo spoke on "Classification and its Discontents: Ordering Animals in the Nineteenth Century" at the Internationales Forschungszentrum Kulturwissenchaften, Vienna. Professor Maier presented a paper on "What Difference Did the Revolution Make? Patents, Corporations, and other Legislative Encouragements to Innovation" at the MIT-Cambridge Conference, England. Associate Professor Anne McCants presented a paper on "Global Trade Brought Home: the Consumption of Tea, Coffee and Porcelain in Middling and Poor Households in the 18th Century" at the University of California. Professor Ravel presented a lecture entitled "Pratiques et représentations du parterre au XVIIIe siècle" at the College de France in Paris, and continued work on a website project on French Theater in the seventeenth and eighteenth centuries. Professor Khoury was the keynote speaker at the Conference on "Emerging Patterns of State and Non-State Relations in the Middle East" in Washington, D.C. Associate Professor Heather Richardson was the Keynote speaker at the British American 19th Century Historians Association annual meeting at Gregynog, Wales. Lecturer Mona Russell presented a paper entitled "Modernity, National Identity, and Consumerism: Visions of the Egyptian Home, 1805-1922" at Ben Gurion University, Israel. Professor Sosin presented a paper on "Reading, Writing, Rhetoric: Palaeography in the Documentary Papyri" at the University of Texas. Assistant Professor Meg Jacobs spoke on "The Politics of Inflation in the 20th Century United States" at Columbia University.

After an extensive national search, the History Faculty appointed Jonathan Zatlin as Assistant Professor in the field of 20th-century European history. He received his doctorate from the University of California at Berkeley for a dissertation on "The Currency of Socialism: Money in the GDR and German Unification, 1980–1990."

Professors Maier, Mazlish, McCants, Perdue, Ritvo, Richardson, Wood and Jacobs participated in the joint Ph.D. program in the History and Social Study of Science and Technology by teaching graduate seminars, setting general examinations, and supervising dissertations. Professors Dower, Ritvo and Professor Khoury advised Harvard graduate students in Japanese, British, and Middle Eastern history respectively. Professor Ravel served on the Curriculum Committee of the graduate program in Comparative Media Studies.

Professor McCants, the current housemaster of Green Hall, is the first recipient of a chair for housemasters named "William and Betsy Leitch Associate Professor of History in Residence." Professor Perdue, was appointed the first holder of the T.T. and Wei Fong Chao Professorship in Asian Civilizations. Professor Sosin was awarded Provost's HASS Funds to support his project, "A Possession for All Time: Perpetual Endowments in the Ancient World." History enrollments totaled 309 in the fall semester and 470 in the spring. Five History majors successfully completed their senior thesis projects: Kathleen M. Barron, "A Row in the Kitchen: Irish Domestic Servants and Their Employers in Boston, 1873," supervised by Professor Richardson; Jade Joan Hon, "How Edward II Transformed Two Centuries: Historical Scholarship on Edward II in Nineteenth-Century England," supervised by Professor Ritvo; Douglas L. Kriner, "Presidential Power: Kennedy, Johnson and the 88th Congress," supervised by Professor Jacobs; Laura McGrath Moulton, "Seeking a Third Way: Nasser Charts an Independent Course for Egypt, 1955–1956," supervised by Professor Khoury; Beverly A. Thurber (Major Departure in Ancient and Medieval Studies), "The Social Impact of Ice Skating in Viking Age Scandinavia and Medieval Europe," supervised by Professor McCants. Three seniors graduated with minors in History. Five new subjects were offered: 21H.342, The

Royal Family (Ritvo); 21H.504, East Asia in the World (Perdue); 21H.206, American Consumer Culture (Jacobs); 21H.404, Economy and Society in the Ancient World (Sosin); and 21H.907, Trials in History (Wood).

Four faculty members led freshman advisor seminars: Professor Khoury on "Conflict and Peace in the Contemporary Middle East," Professor McCants on "A Brief History of Cosmology," Professor Ravel on "Bad Plays," and Professor Ritvo (in collaboration with MIT Museum Director Jane Pickering) on "Behind the Scenes at the Museum." Professors McCants, Ravel, and Ritvo supervised UROP projects.

Professor Maier served on the Faculty Policy Committee. Professor Perdue served as co-chair on the search committee for the S.C. Fang Chair in Chinese Language and Culture. Professor Ritvo was a member of the HASS Overview Committee. Professor Wood served as the Chair of the Ad Hoc Library Committee. Professors Wood and McCants participated in the Women's Studies Program. Professor Jacobs directed the Truman Scholarship Committee. Professor McCants served as president of MIT's Phi Beta Kappa chapter. Two historians were housemasters: Professor McCants of Green Hall, and Professor Watson of Baker House.

The Sahin Lecture Series for 2000–2001 included the following presentations: Roger Bagnall on "Social History and Social Archaeology: Launching a New Excavation in Egypt," Juha Siltala on "Flexible Minds at the Flexible Labor Market: The Emergence and the End of the Psychological 'Self,'" and Edward Cohen on "The Economic Cost of 'Manliness' in Classical Athens." Professor Mazlish, again, jointly organized the monthly meetings of the History and Literature Workshop, and Dean Khoury directed the Bustani Middle East Seminar.

More information about the History section can be found online at http://web.mit.edu/history/www/.

Harriet Ritvo

LITERATURE

The highlights of 2000–2001 included two new appointments, a promotion and several faculty awards. Dr. William Uricchio, former Director of the Media Center at the University of Utrecht, was appointed Professor of Comparative Media Studies beginning July 2000. Noel Jackson, whose field is British Romanticism, was appointed Instructor of Literature beginning July 2001. Associate Professor Christina Klein was promoted to Associate Professor, beginning July 2001. Professsor Peter S. Donaldson was selected as the Class of 1961 Fellow, and Associate Professor Shankar Raman received the Wade Award. Academic year 2000–2001 also saw the graduation of the first class in the Masters of Science program in Comparative Media Studies. The Comparative Media Studies program is directed by Professor Henry Jenkins and is a joint program of Literature, Foreign Languages and Literatures and the Program in Writing and Humanistic Studies.

ACADEMIC PROGRAM AND STUDENT ENROLLMENT

During the past year, 1000 undergraduates enrolled in Literature subjects, eight were registered as Literature majors, 25 as minors, and 144 concentrators in Literature. A number of Literature seminars were revised and new topics offered this year: American Orientalism (21L504) taught by Professor Klein; Herman Melville and Toni Morrison (21L702) taught by Lecturer Wyn Kelley; Renaissance Drama: Shakespeare and his Contemporaries (21L703) taught by Professor Raman; Tom Stoppard/Caryl Churchill (21L703, Spring Term) taught by Associate Professor Diana Henderson; Spenser/Milton (21L704) taught by Professor Mary Fuller; George Eliot (21L705, Fall Term) taught by Professor James Buzard; Geoffrey Chaucer (21L705, Spring Term) taught by Associate Professor James Cain; Concepts of Love and Sex in the Western World (21L707) taught by Professor Irving Singer (Philosophy).

RESEARCH AND PUBLICATION

Professor Donaldson completed several articles on Shakespeare on film and a multimedia essay on the Ian McKellen *Richard III*, parts of a larger project on Shakespeare film in the context of media history. Professor David Thorburn is co-editing *the Media in Transition Reader* for publication by MIT Press. Professor Ruth Perry contributed an article to *Women and Literature in Britain 1700–1800*, ed. Vivien Jones. Professor Stephen Tapscott's edition of Pablo Neruda's *100 Sonnets of Love* has gone into a new edition. Professor John Hildebidle published poems in *Poetry Ireland* and the *Dan River Anthology*. Professor Henry Jenkins published a regular column on media in *Technology Review* and an article in *Independent School.* His work also appeared in the collected volume *American Cultural Studies,* ed. Roberta Pearson and John Hartley, and in *Reinventing Film* Studies, ed. Christine Gledhill and Linda Williams. Professor Uricchio published articles on film history in *Storio del Cinema*, ed G.P. Brunetta, and in *KINtop: Jahrbuch zur Erforschung des fruhen Film,* and is completing his book on German television during the Third Reich. Professor Fuller is working on a study of Hakluyt's *Principal Navigations* and published reviews in *Terrae Incognitae* and *Shakespeare Quarterly* as well as an article in *Travel Knowledge,* ed. Ivo Kamps and Jyotsna Singh. Professor Buzard published reviews in *Victorian Studies* and elsewhere and continues work on his book on autoenthnography in British fiction. Professor Henderson published four articles, including contributions to *A Companion to English Literature and Culture*, *Shakespeare and his Contemporaries in Performance*, *British Writers* and *The Wit to Know: Essays on English Renaissance Literature for Edward Tayler.* Professor Raman published a review in *Renaissance Quarterly,* an article in *Travel Knowledge*, and continues work on his book on representation in early Modern England. Professor Klein is making final revisions on her book *Cold War Orientalism*, to be published by the University of California Press. Professor Cain completed an article for *Exemplaria* and is preparing his book on 12th century statecraft and the performance of gender for publication.

ELECTRONIC PROJECTS

Professor Donaldson's work under the MIT-Microsoft iCampus Alliance continued this year with the first deployment of the Shakespeare Video Annotation System (SVAS) in MIT Shakespeare classes and in a distance seminar under the auspices of the Shakespeare Association of America. Funding for SVAS has been renewed for the coming year, and the system will be used to support remote collaboration with faculty and students at Cambridge University. The Metamedia project, which will create a number of "mini archives" to support multimedia teaching across a broad range of humanities subjects was funded this year by the d'Arbeloff Fund for Education. Professor Jenkins will serve as PI for this effort, and Professor Donaldson, Lecturer Kelley and other Literature faculty will participate. Professor Buzard, as co-editor of the international *Monuments and Dust* project on Victorian England, is editing 19th century issues of *Punch* for digital publication. Professor Thorburn is editor-in-chief of the Media in Transition website and directs the MIT Communications Forum which this year began webcasts of its proceedings. In addition, a number of Literature faculty including Professors Donaldson, Thorburn, Cain and Lecturer Kelley participated in the Electronic Arts Creative Leaders workshops held at MIT and in California, at which MIT humanities faculty joined with creative leaders in the game industry to explore connections between traditional narrative and expressive forms and the emerging genre of electronic games. Professor Uricchio produced *Analysing Images,* an interactive CDROM for film study funded by the Dutch Ministry of Education. Professor Klein began work on a web-based collaborative distance course on U.S.-Asian Transnational Cultures with colleagues in Singapore and Bangladore, India.

CONFERENCES AND INVITED ADDRESSES

Professor Donaldson delivered the Hudson Strode Memorial Shakespeare lecture at the University of Alabama, chaired the distance seminar on Shakespeare on Film at the annual meeting of the Shakespeare Association of America meeting in Miami, co-chaired the Shakespeare and Film session at the International Shakespeare

Association meeting in Valencia, Spain, and organized a series of workshops at MIT and Cambridge University on Shakespeare and Renaissance Drama in Performance, in which Professors Fuller and Henderson also participated. Professor Alvin Kibel presented papers at the Mediterranean Studies Conference at Aix-en-Provence, at the University of York (UK), and at the International Conference on the History of Technology in Prague. Professor Perry spoke at the Jane Austen Society in Boston, at the New England Eighteenth Century Society meeting in Portland, Maine, participated in a panel at the Association for Eighteenth Century Studies in New Orleans, and spoke at the Huntington Library, and at the University of the West Indies, Barbados. Professor Jenkins spoke at SIGGRAPH; at the American Library Association; at the Casey School of Journalism (University of Maryland); at the University of Southern California; at the Game Developers Conference in San Jose, CA; at the Technical College of British Columbia; at Melbourne University; at the University of Sydney; at the University of South Australia (Adelaide); at the University of Brisbane; at Canterbury College (Christchurch, NZ); at the Maine Librarians' Association in Portland, Maine; at the Electronic Entertainment Exposition in Los Angeles; and at the Society for Cinema Studies in in Washington DC. Professor Uricchio spoke at the Electronic Arts Workshop in Walnut Creek, CA; at the Historical Art and Culture Center at Erasmus University, Rotterdam, NL; at the Ruhr-Universitaet Bochum, Germany; at the University of Paderborn, Germany; at the European Science Foundation meetings in Bilbao, Spain and Palermo, Italy; at the Bauhaus University, Weimar; at the Center for Documentary Films in Berlin; at the Groningen Museum of Art; at Ben Gurion University in Israel; at the University of Stockholm Sweden; at the Cinémathèque québécois in Montreal and at the Royal Dutch Academy of Science in Amsterdam. Professor Buzard spoke at MLA, at the Northeast Conference on British Studies, at the University of North Carolina, at the Dickens Project Conference at the University of California-Santa Cruz, at the European University Institute in Florence, Italy, at the City University of New York, at Indiana University, at the Travel and Nation Conference in London, and organized a panel at the Locating the Victorians Conference at the University of London. Professor Fuller led a seminar on travel literature at the World Shakespeare Conference in Valencia, Spain; participated in the panel on Early Modern Orientalism at the Shakespeare Association of America meeting in Miami; and spoke at the British Academy and the Florida Institute of Technology. Professor Henderson spoke at the Group for Early Modern Culture Studies in New Orleans, at the Renaissance Society of America in Chicago, at the Mediterranean Studies Association at Aix-en-Provence, at the World Shakespeare Congress, at the the Universities of Pittsburgh and New Hampshire, and chaired a panel at the Shakespeare Association of America in Miami. Professor Klein presented new work on transnationalism at Boston College. Professor Raman presented papers at the World Shakespeare Congress, the Renaissance Society of America meeting in Chicago, at the Mediterranean Studies Conference in Aix-en-Provence, at the Postcolonial Studies Conference in Kracow, Poland, and at the MLA meeting in Washington DC.

AWARDS, SERVICE AND GRANTS

Professor Donaldson was appointed Class of 1961 Fellow for a period of three years. Professor Raman received the Wade Award for his proposal "Crises of Representation in Early Modern Europe." Professor Perry received the American Society of Eighteenth Century Studies award for outstanding women in eighteenth century studies.

Professor Jenkins served as Director of Comparative Media Studies and as Housemaster of Senior House and as a member of the Creative Arts Council. Professor Donaldson served on the Council for Educational Technology and the Provost's Committee on Intellectual Property. Professor Fuller served on the MIT Faculty Committee on Nominations. Professor Buzard served as chair of the Humanities, Arts and Social Sciences Overview Committee (HOC). Professor Henderson served on the editorial board for *Renaissance Quarterly* and *Journal for Early Modern Cultural Studies*. She also serves as Shakespeare Delegate to the MLA General Assembly and co-chairs the seminar of Women and Culture in Early Modern Europe at the Harvard Humanities Center. At MIT she serves on CUP and on the Edgerton Prize Committee.

More information about the Literature section can be found online at http://web.mit.edu/lit/www/.

Peter S. Donaldson

MUSIC AND THEATER ARTS

Music and Theater Arts continues to afford students at MIT the opportunity to experience the unique language and process of the arts. Faculty and teaching staff help students understand art's demand for rigor and discipline and its non-quantitative standards of excellence and beauty. A strong, comprehensive program in both Music and Theater Arts, encompassing history, theory and performance—taught by a faculty and staff of the highest caliber whose ongoing professional activities inform their teaching—has been and will continue to be our hallmark. Because it is comprehensive, the academic program continues to produce graduates who have the talent and desire to extend their education in Music or Theater beyond the undergraduate level.

HIGHLIGHTS OF THE YEAR

Professor Ellen Harris was appointed Section Head in July of 2000. The MIT Symphony Orchestra, Concert Choir and Wind Ensembles took part in the celebration of the School of Humanities, Arts and Social Sciences 50th anniversary with a concert in Kresge Auditorium. Under the direction of Assistant Professor Dante Anzolini with Senior Lecturer David Deveau as piano soloist the Orchestra and Chorus performed Beethoven's *Choral Fantasy*. Renovations were completed on the new faculty and administrative offices for the Section in Buildings 10 and 4 and the move was completed in February.

HONORS AND AWARDS

Professor Peter Child was the winner of the *Music of Changes* composition competition and will receive a commission and a concert devoted to his music. Associate Professor Janet Sonenberg was named a Margaret MacVicar Fellow. Professor Evan Ziporyn was awarded a commissioning grant from Meet the Composer's *Commissioning Music/USA 2000* program. Assistant Professor Thomas DeFrantz received the Class of 1948 Career Development Professorship.

PROGRAM HIGHLIGHTS

Enrollments in Music and Theater were 1038 and 368, respectively, for a total of 1406. Music and Theater Arts continued to host the MIT Chapel Series, a successful concert series featuring local solo and group performers. The MIT Guest Artist Series hosted the Artis String Quartet and the Cypress String Quartet. The Music Section celebrated Senior Lecturer Ed Cohen's 60th birthday with a concert of his music conducted by Institute Professor John Harbison.

Theater Arts and The Shakespeare Ensemble presented Shakespeare's *Richard III* directed by Kurt Lancaster and *The Rover* by Aphra Behn directed by Lecturer Kim Mancuso. Dramashop produced Sheridan's *School for Scandal* directed by Senior Lecturer Michael Ouellette. *Bhoma* by Badel Sircar was produced by Dramashop and directed by visiting director Sudipto Chatterjee. Dramashop presented an evening of student written and student directed one act plays. Associate Provost Alan Brody directed Playwrights in Performance in two evenings of one-act plays by MIT student playwrights.

ACHIEVEMENTS

Professor Jeanne Bamberger guest lectured at New England Conservatory, Northwestern University and Tel Aviv University. She installed a computer exhibit *Tuneblocks* at the MIT Museum.

Professor Child completed a commission for the Hopkins Center at Dartmouth College. His new work *Refrain* was performed at Boston Conservatory, Eastman School of Music, Rice University and Oberlin College Conservatory. The group Interensemble performed his Trio for clarinet, violin and piano in Italy.

Professor Harbison was in residence at the Tanglewood Bach Institute, Tanglewood Composers Seminar and Florida State University. His *Partita* was premiered by the Minnesota Orchestra and *North and South* by the Chicago Chamber Musicians. The Chicago Lyric Opera performed his new opera *Gatsby*. He served on the Pulitzer Prize jury this past year.

Professor Harris completed an edition of 16 of Handel's Alto Cantatas, published articles in the *Handel-Jahrbuch* and the American Handel Society Newsletter. She was consultant to the Santa Fe Opera and lectured for the Boston Symphony Orchestra and Boston Baroque.

Professor Lowell Lindgren presented papers in Toronto, Ontario; Florence, Italy; and Dublin, Ireland. His publications include 26 entries for the *New Grove Dictionary of Music*, the article *Italian Violoncellists* for *Music in Eighteenth-Century Britain*, and *Oratorios Sung in Italian at London, 1734–82* for *Quaderni Della Rivista Italian di Musicologia.*

Professor Marcus Thompson performed at the Seattle Chamber Music Festival, the Sitka Summer Music Festival and the Montreal Chamber Music Festival. He toured Holland and Belgium and performed with the Czech National Symphony Orchestra. He was a member of the Jury for the Julius and Esther Stuhlberg Competition.

Professor Ziporyn performed on tour with Paul Simon, performed with Bang on a Can, with Steve Reich and Marcello Zarvos.

Professor Anzolini made his debut at Carnegie Hall conducting the American Symphony Orchestra with piano soloist Leon Fleisher.

Professor DeFrantz contributed a chapter to the book *Embodying Liberation: African American Dance*, Alison Goeller and Dorothea Fischer-Hornung, editors, German Press, 2001. He was invited to lecture on Alvin Ailey at the University of Michigan, Barnard College in New York City and Charles V University in Paris. He was an invited lecturer at the Swedish Biennial of Dance at Umea, Sweden. He directed and choreographed *ClimActs!* and *Queer Theory: A Musical Travesty* at Theater Offensive of Boston, Boston Center for the Arts.

Senior Lecturer Deveau performed at Wolftrap in Virginia, Mainly Mozart Festival in San Diego and Strings in the Mountains Festival in Colorado. He soloed with the New Philharmonia Orchestra and performed live on WETA and WQED radio. He continues as Artistic Director for the Rockport Chamber Music Festival.

Senior Lecturer Martin Marks recorded his piano score for the film *Where Are My Children?* for Turner Classic Movies. He lectured at Washington University in St. Louis, chaired the session Music for the Movies at the Toronto 2000 Musical Intersections Conference. Five of his short silent film scores were performed at a program for the Academy of Motion Picture Arts and Sciences. Four of his short film scores were performed in the program *Exceptional Amateur Films* at the Portland Museum of Arts, Portland, Maine. He presented the paper *Copland as a Hollywood Film Composer and his culminating score for 'The Heiress'* at Northeastern University.

Senior Lecturer Ouellette performed in *Light Up the Sky* at the Williamstown Theater Festival. He published *Music Inspired by Shakespeare* in *Shakespeare's World and Work*, edited by John F. Andrews, Scribner and Sons, New York.

Lecturer Frederick Harris guest conducted the New Hampshire Philharmonic Orchestra. He published *Conducting with Feeling*, Meredith Music Publications and an article *Opening the Score to the Audience.* He was appointed assistant conductor of the Boston University Tanglewood Institute Young Artists Wind Ensemble and is the recipient of the Frank L. Battisti Conducting Residency at the Boston University Tanglewood Institute.

Lecturer Laura Harrington received the Independent Reviewers of New England Award for Best New Play and won the Clauder Playwriting Competition for her play *Hallowed Ground.*

Lecturer Mark Harvey won the Independent Music Award in the jazz category for his composition *Scamology.* He released his fifth CD of original works performed by Aardvark Jazz Orchestra. He organized the symposium Illuminations and Transformations: Cross-Cultural Spiritual Dynamics in Music, Dance, Text, and Film and presented a paper for the Society for the Arts, Religion and Contemporary Culture in New York, New York.

Lecturer Elena Ruehr was named Composer in Residence for the Boston Modern Orchestra Project. Her compositions *Lullabies* and *Spring Songs* were performed in New York, California, Massachusetts, Florida, and Indiana. *The Law of Floating Objects* was performed as part of the CyberArts Festival at Brandeis and with the Nicola Hawkins Dance Company. The Borremeo Quartet performed the *Third String Quartet* at the Rockport Chamber Music Festival and the Shanghai Quartet performed *Song of the Silkie.*

PERSONNEL

Professor Bamberger retired on June 30, 2001 and will be appointed Professor without tenure. Professor DeFrantz was promoted to Associate Professor without tenure effective July 1, 2001. Martin Marks and George Ruckert were re-appointed as Senior Lecturers in Music. Michael Ouellette was re-appointed as Senior Lecturer in Theater. Lecturer William Cutter was named Director of Choral Programs and Lecturer Frederick Harris was named Director of Wind Ensembles. Music and Theater Arts affirms its commitment to diversity within its disciplines and among its staff. Seven members of our full-time faculty and teaching staff of twenty are under-represented minorities or women.

More information about Music and Theater Arts can be found online at http://mit.edu/mta/www/.

Ellen T. Harris

PROGRAM IN WRITING AND HUMANISTIC STUDIES

The Program in Writing and Humanistic Studies (PWHS) teaches and encourages MIT students to write with force, clarity, and creativity in a wide range of forms. Students write fiction and poetry. They write essays and journalism. They do technical writing. They write for electronic media. And they study the forms, techniques, and traditions that bear upon each of these genres. The members of our program include scholars, journalists, and artists who themselves write in these areas, and who publish research in a variety of humanistic fields, both traditional and interdisciplinary. The faculty includes joint appointments in History, History of Science and Technology, Physics, and Mechanical Engineering. Program members work in three different contexts: in the core academic curriculum, made up of SHASS distribution subjects and electives; in outreach programs throughout the Institute in writing-across-the-curriculum; and in the Writing and Communication Center. Program subjects during the past year enrolled 1368 students (up from 1318 the previous year), of whom nine were majors, 27 were minors, and 121 were concentrators in writing for the SHASS requirement. Our writing-across-the-curriculum programs brought writing instruction to more than 1500 students in departments throughout the Schools of Science, Engineering and Architecture. Finally, our Writing and Communication Center staff assisted a total of 762 clients for a record total of 2988 visits, providing assistance with reports, papers, oral presentations, and thesis projects.

RESEARCH AND PUBLICATIONS

Professor Anita Desai's novel *Fasting, Feasting* was published in Italian, French, Spanish, Portuguese, and Danish editions in the fall of 2000. Professor Alan Lightman's novel *The Diagnosis,* published by Pantheon in September 2000, was given extensive reviews in the *New York Times*, *The New York Review of Books*, and *The New Yorker* magazine. Professor Robert Kanigel's popular history of travel and tourism, *High Season,* will be published by Viking in June of 2002. Professor Kenneth Manning's exhibit of the history of SHASS, which was displayed for four months at the Compton Gallery, has been permanently installed in the lobby of Building 14. Professor Cynthia Wolff continues work on a literary biography of Willa Cather. Professor James Paradis continues his research on Samuel Butler. Associate Professor Helen Elaine Lee is currently working on a collection of short stories about prison and prisoners' lives. Associate Professor Susanne Klingenstein is working on two new books, *Preserving the Past: The Murder of the European Jews in Germany's Cultural Memory* and *The Art of Medicine: A Literary Anthology.* Adjunct Professor Joe Haldeman's science fiction novel *The Coming* was published by Ace Books in December 2000. Senior Lecturer Edward Barrett's reference volume, *The MIT Guide to Web Design*, was published by MIT Press in April of 2001. *Sheepshead Bay*, a major collection of his new work, will be published by Zoland Books in October 2001. Writer-in-Residence Stephen Alter's *Amritsar to Lahore: A Journey Across the India-Pakistan Border* was published by the University of Pennsylvania in November of 2000. His work, *Sacred Waters: A Pilgrimage Up the Ganges River to the Source of Hindu Culture*, will be published by Harcourt Brace in October of 2001. Dr. Leslie Perelman, Director of Writing Across the Curriculum, is serving as Principal Investigator for the TestWrite Project, funded by the MIT-Microsoft I-campus partnership. This initiative is developing a national consortium of universities to develop innovative and educationally valid tests over the Word Wide Web. Lecturer Ann Snodgrass's work, *Knowing Noise: The English Poems of Amelia Rosselli,* was published by Peter Lang Publishing. Lecturer Elizabeth Fox continues her work on D. H. Lawrence, published several review essays, and delivered a paper in Bialystok, Poland.

ACADEMIC PROGRAMS AND INITIATIVES

The Program in Writing and Humanistic Studies is supporting three major SHASS initiatives at the Institute: the Communication Requirement, the Comparative Media Studies M.S. Program, and the Graduate M.S. Program in Science Writing.

The new Communication Requirement, which was approved last year by the faculty, will be implemented with the arrival of the Class of 2005. The new requirement replaces the old proficiency-based Writing Requirement with a new, instructionally-based requirement: every undergraduate must take some form of instruction in writing and speaking each year of his or her four-year program. Roughly 20 percent of incoming MIT freshmen are now required, on the basis of their performance on the Freshman Essay Evaluation (FEE) test, to take an expository writing class. Dr. Rebecca Faery, Director of First Year Writing, has undertaken a program of redesigning our first-year expository writing curriculum, and over this past year has completed an extensive training program for our first-year writing instructors. This program has been successful in improving the standards, interest, and consistency of our expository writing subjects. It has also introduced new elements of oral communication to the traditional subject matter.

As part of instituting the new Communication Requirement, we have also revamped and expanded our writing-across-the-curriculum (WAC) programs. The object of these decentralized programs is to take writing instruction and evaluation into core subjects of science and engineering departments throughout the Institute. Two years ago, the Office of the Writing Requirement moved from the Office of the Dean of Students to PWHS, where Dr. Perelman and Ms. Madeline Brown assumed the respective duties of Director of Writing Across the Curriculum and Coordinator of Writing Initiatives. Dr. Perelman and Ms. Brown have expanded the WAC teaching efforts of PWHS throughout every department at the Institute (except the Sloan School), and they have experimented extensively with innovative instructional programs.

In preparing for the Communication Requirement, we have strengthened the Writing and Communication Center. This PWHS facility dealt with a record number of visits (a 17 percent increase over last year). Anticipating an increased demand on the center's resources as the result of the Communication Requirement, the center's director, Dr. Stephen Strang integrated several new tutoring strategies into the center's activities, including special practice seminars on oral communication, an online center, an online tutor (which accepts writing samples of up to 1000 words and was consulted 60 times), and an extended hours program in the evenings and on weekends.

The second major initiative of PWHS has been its collaboration with the Foreign Languages and Literatures section and the Literature Faculty to support the Comparative Media Studies (CMS) Graduate Program. The three sections continue to pool resources, collaborate in developing an interdisciplinary graduate curriculum, share in the advising of graduate students, and jointly govern the policy of CMS. Dr. Barrett, who teaches the writing in digital media subjects in PWHS, taught two subjects taken by CMS students: The CMS Workshop (CMS.950) and Writing in Cyberspace (21W.785). In addition, the PWHS head was a member of the governing board for CMS, which met regularly throughout the year to set policy and make decisions. Faculty of PWHS will also serve on search, curriculum and other administrative committees to help run the CMS.

Over the past year, the graduate program in science writing, PWHS's third major initiative, has successfully navigated through MIT's various administrative committees, beginning with School Council in the fall and culminating in the spring in formal approval by the Faculty. The graduate program plans to accept its initial group of students in September 2002. Professor Kanigel will direct it; Professor Lightman, who was instrumental in helping to launch the program and was its co-director, has relinquished his Burchard professorship, but will nonetheless teach in the graduate program, and lend his stature to it. Others who worked on the program during the past year were Dr. Boyce Rensberger (who heads the Knight Fellows Program), Professor Manning, Lecturer B. D. Colen, and Professor Paradis. A search has been set in motion for an additional faculty member. Over the past year, we have refined a number of important curricular details; taken early steps toward developing a fundraising program; begun the process for hiring the program's administrative officer; and started work on the brochure, poster, and web site needed to attract applications to any new program. The coming year will be a busy one. We will be publicizing the new program, selecting the initial entering class, refining the advanced science writing seminar that is the curricular heart of the program, beginning to set up a system for student internships, working on fundraising, and working through the office of the Communications Requirement to set up teaching assistantships.

SERVICE, GRANTS, AND AWARDS

Professor Lightman's new novel was a finalist for the National Book Award. Professor Kanigel served as judge for the Susan Hacker Prize for the Society of the History of Technology. Professor Desai was a colloquium panelist at the SHASS 50th anniversary celebration. She was named a Literary Lion of the Boston Public Library. Dr. Barrett co-chaired the admissions committee for the Comparative Media Studies Program, served on the CMS Steering Committee and the Technology and Space Committee. He is also the General Editor of the MIT Press Series on Digital Communication that was cited by ACS for special distinction. Writer-in-Residence Alter gave a Burchard Scholars lecture/reading about the writing of *Amritsar to Lahore: A Journey Across the India-Pakistan Border.* Lecturer Snodgrass won the Rella Lossy poetry award for 2001 from the American Poetry Center and Poetry Archives at San Francisco State University.

PERSONNEL

Professor Lightman has stepped down as Burchard Professor of Writing and will become Adjunct Professor of Writing. He will continue to participate in the development of the Graduate Program in Science Writing. Professor James H. Williams, School of Engineering Professor in Teaching Excellence, has received a joint appointment as Professor of Writing and Humanistic Studies. Professors Paradis and Wolff will be on sabbatical leave during AY2002. Professor Lee will take a junior faculty leave during the fall term. Professor Kanigel will be interim Head of PWHS for the year.

We have 52 percent women on our total teaching staff and 46 percent women on our core faculty. We also have 11 percent minority members on our total staff and 23 percent minority members on our core faculty. Two of our teaching staff—an associate professor and a full professor—are African-Americans.

More information about the Program in Writing and Humanistic Studies can be found online at http://web.mit.edu/humanistic/www/.

Robert Kanigel

DEPARTMENT OF LINGUISTICS AND PHILOSOPHY

The Department of Linguistics and Philosophy divides into two sections consisting of twenty-six faculty members (four of them jointly appointed), sixty-nine graduate students, thirteen undergraduate majors, two dozen or so visiting scientists and scholars, an administrative officer, a student administrator, network administrator, lab manager, and six support staff members. Each section operates independently; yet between them there is a significant overlap of intellectual interests in education and research, among the faculty, students, and visitors. In the most recent (1995) National Research Council rating of graduate programs in the United States, Linguistics and Philosophy were ranked first and tenth, respectively, on faculty quality and second and seventh, respectively, on program effectiveness. This year's undergraduate class enrollment of 737 students is consistent with the increase over the last few years.

RESEARCH

Linguistics

The linguists continue to pursue an account of natural language in terms of principles of computation and representation. The Minimalist Program for Linguistic Theory, Optimality Theory, and the Theory of Distributed Morphology offer somewhat different yet sometimes complementary suggestions for the course that the pursuit might follow. These ideas continue to be explored, developed, and challenged by MIT graduate students, faculty and visitors in research on syntax, semantics, morphology, phonology, and on the interfaces between these modules of the grammar of natural language.

Neurolinguistic research continues with the move of the KIT/MIT MEG Lab to Building 24. The MEG Lab hosts interdisciplinary research by scientists across MIT and the greater Boston scientific community. The Department has also continued to provide support for experimental research in language acquisition, acoustic phonetics, and sentence processing.

Philosophy

Research in philosophy is not so neatly programmatic as it is in linguistics; thus it is best simply to list the wide range of topics pursued in current research in philosophy at MIT including but not exhausted by the following: theories of consciousness and the mind-body problem; causation and laws of nature; analysis of fundamental metaphysical concepts: substance, attribute, essence, set, identity, etc.; problems at the intersection of ethics and historical sociology; foundational questions of quantum physics; analysis of natural laws and their role within scientific theories; applied aesthetics; the foundations of "possible worlds" semantics for modal and conditional logics; the ontology of events; the identity across time of people and other physical objects; the principles of rationality governing ethical reasoning; and the role of evaluative thoughts in practical reasoning.

PUBLICATIONS

As in the past, the faculty on both sides of the department participated in a large number of colloquium and acted as keynote speakers at conferences and workshops in various parts of the United States and the world. In addition a number of our faculty served as editors and/or members of editorial boards for numerous journals both in the United States and abroad. They also published a large number of journal articles, book chapters, and reviews. Books published in 2000–2001 include: Institute Professor Noam Chomsky published four books: *Rogue States: The Rule of Force in World Affairs,* South End Press; *The Architecture of Language*, Oxford University Press; *A New Generation Draws the Line, Verso;* and *Su natura e linguaggio*, Universita Degli Studi Di Siena. Professor Irving Singer also published four books this year*: George Santayana, Literary Philosopher*, Yale University Press; *Reality Transformed: Film as Meaning and Technique*, MIT Press*; Feeling and Imagination: The Vibrant Flux of Our Existence,* Rowman and Littlefield Publishers*;* and *Sex*: *A Philosophical Primer*, Rowman and Littlefield Publishers. Professor Judith Thomson published *Goodness and Advice*, Princeton University Press. Professor David Pesetsky published, *Phrasal Movement and its Kin*, MIT Press. Professor Kenneth Hale published two books*: Dine Bizaad Naalkaah: Navajo Language Investigations*, along with Professor Theodore Fernald, *Working Papers on Endangered and Less Familiar Language*, Volume 3, MITWPL; and *The Green Book of Language Revitalization,* with Professor Leanne Hinton, Academic Press. Professors Alec Marantz, Wayne O'Neil, and Yasushi Miyashita published, *Image, Language, Brain,* Papers from the first Mind Articulation Symposium, MIT Press. Professor Joshua Cohen and Professor Joel Rogers jointly edited three books from Beacon Press: *What's Wrong with a Free Lunch?; Is Inequality Bad For Our Health?*; *The New Environmentalism.* In addition, Professor Robert Stalnaker, Associate Professor Alex Byrne, and Associate Professor Ralph Wedgwood edited a collection of essays, *Fact and Value: Essays in Ethics and Metaphysics for Judith Jarvis Thomson*, MIT Press. Assistant Professor Norvin

Richards co-edited *MIT Working Papers in Endangered and Less-Familiar Languages, Volume 2: Topics in Australian Languages*, MITWPL.

HONORS AND AWARDS

Professor Pesetsky was appointed the Henrietta Harvey Distinguished Lecturer, Memorial University, Newfoundland, March 2001. Professor Wedgwood was awarded the Young Epistemologist Prize at the Rutgers Epistemology Conference in 2001.

PERSONNEL

Professor Michael Kenstowicz was on a sabbatical leave for the fall semester and an administrative leave in the spring. In addition, Professors Byrne and Wedgwood were on junior faculty research leaves for the spring semester.

Professor Wayne O'Neil retired from the Linguistics Section as of June 30, 2001. Associate Professors Sabine Iatridou and Stephen Yablo were promoted to the rank of Professor. Associate Professor Kai von Fintel was awarded tenure.

We have reached our revised affirmative action goal of six women on the faculty with the transfer of Professor Suzanne Flynn's line to our department. In addition, we have hired Donca Steriade as a Professor of Linguistics. She will begin her tenure with us on July 1, 2002, bringing to seven the total number of women faculty members. We will continue our efforts to recruit qualified women and minority candidates to the faculty.

More information about this department can be found online at http://web.mit.edu/philos/www/ or http://web.mit.edu/linguistics/www/.

Alec Marantz

DEPARTMENT OF POLITICAL SCIENCE

The MIT Department of Political Science offers a full undergraduate curriculum in political science; provides graduate education and research training at the highest level of excellence; maintains an environment in which faculty and advanced students can carry out original research on political behavior, processes, institutions, and policies; and contributes to the capacity of governmental and private organizations at the local, national, or international level to deal effectively and humanely with important political issues. Throughout, the department aims to create a community of men and women—senior and junior scholars, students and staff—that is rich and diverse in terms of gender, race, and national origin.

The key to success in all these goals lies in recruiting and nurturing an outstanding faculty, devoted both to research and teaching. In this connection, I am pleased to report that we have, in the past four years, successfully recruited seven outstanding new faculty (five assistant professors, two associate professors), two of whom will be joining us this fall.

EDUCATIONAL INITIATIVES

The department is helping MIT take the lead nationally in enhancing the education of technologically sophisticated undergraduates by exposing them to the practical world of politics and policymaking, while maintaining a high degree of academic rigor. Since 1994–95, we have provided a summer internship in Washington, DC for MIT students from across all disciplines. The internship's purpose is to provide a closer and more realistic look at policymaking than is possible in classroom settings. Students are required to enroll in a subject that introduces them to the contexts of policymaking. To date, more than eighty students have been placed in such organizations as: The White House Office of Science and Technology Policy, The U.S. Department of Energy, the Institute of Medicine's Board on Global Health, the U.S. General Accounting Office's Office of Transportation Issues, the Office of Management and Budget, the World Bank, The Economic Policy Institute, the American Association for World Health and the U.S. House of Representatives Science Committee. The program, which allows MIT's technically-oriented students to experience how institutions vital to their later success operate, also gives the federal government and other policymakers early access to the best young scientists and engineers in America. With the help of a generous pledge from Dana Mead, we plan to expand the number of interns next summer to 13, with three each year designated as Dana Mead Interns.

For three years now, the Political Science and Economics Departments have also collaborated on a joint Political Science/Economics Washington Summer Internship Program. Two Political Science students and three Economics students were selected to join the Science and Technology interns in Washington, D.C. this summer. Political Science major Victoria Anderson (Political Science and Nuclear Engineering) is spending the summer at the U.S. Department of Energy; Jessica Hall is at the Plexus Consulting Group; and Allison Horst is at the MIT Washington D.C. Office.

Professor Suzanne Berger also created the MIT France Program, which is coordinated under the MIT International Science and Technology Initiatives (MISTI), along with the MIT-Japan, MIT-China, MIT-Germany, MIT-India, and MIT-Italy Programs. The MISTI-France Program began in September, 2000. Through these programs, the department has placed nearly 1000 students in internships over the past 20 years and we have every reason to expect that MISTI-France will be just as successful.

Professor Nazli Choucri has developed the Global System for Sustainable Development (GSSD)—an Internet-based set of experiments in international, distributed, multi-lingual and multi-cultural knowledge development, sharing and networking. Associate Professor Dan Kryder has incorporated the Kennedy, LBJ, and Nixon White House audiotapes into his courses as a teaching tool. Professor James Snyder, jointly with Harvard University, co-organized the bi-weekly seminar on positive political economy. Professor Charles Stewart is continuing to participate in the Residence Based Advising pilot project at McCormick Hall, for the freshman class entering Fall 2001.

Jointly with DUSP and Economics, the department recently established a minor in Public Policy. The program is now entering its third year, and is attracting a fair number of students to its courses. Currently, eight members of the class of 2002 have declared a Public Policy minor.

As part of an ongoing review of course offerings, several new subjects have been developed this past year on both the graduate and undergraduate level. Professor Stephen Ansolabehere and Assistant Professor Chappell Lawson designed a new course "Media Politics" which will be offered in 2001–2002. Lecturer Margaret Burnham will offer her new course "Political Trials" in spring 2002 and will teach "The Supreme Court" in the fall as a Communication Intensive course for the first time. Assistant Professor Brandice Canes-Wrone directed a reading seminar on the U.S. Courts for an advanced undergraduate. Assistant Professor Kanchan Chandra taught a new, year-long graduate workshop on ethnic politics. Assistant Professor Chappell Lawson developed and taught "Introduction to Comparative Politics," with Assistant Professor Jonathan Rodden, "Democratization in Asia, Africa, and Latin America." Associate Professor Kenneth Oye offered his new course "Science, Technology and Public Policy" in fall 2000 term. Professor Barry Posen expects to teach a new graduate course in the spring, on an experimental basis, called "Regional War, Civil Conflict and Great Power Intervention, 1990 to Present." Professor Harvey Sapolsky has taught a Summer Professional Institute course that is extremely successful in terms of enrollment and is planning a joint course with Steve Rosen at Harvard. Professor James Snyder is currently helping develop a new major field in Political Economy for Ph.D. students in economics. Associate Professor David Woodruff has substantially revised the syllabus for a fall course on institutional economics and is improving the HASS-D course on Soviet History by including more the primary source materials in the readers.

Several of these new undergraduate courses emerged from faculty discussion (prompted in part by conversations with Visiting Committee) about the need for a more structured undergraduate curriculum with better-defined portals into the program and clearer tracks through it. As part of that discussion, we also reorganized the numbering of courses and their representation in the catalogue.

At the end of the spring semester, the department also initiated a thorough review of the Graduate Program. Department faculty share the sense that the program needs more of a common intellectual core and more structured expectations. The current expectation is that the proposal will emerge by the end of the fall term.

STUDENT RECRUITMENT, PLACEMENT, AND ENROLLMENT

After two very good years, the department had a poor year at graduate recruitment: we succeeded with only two of our top 15. The results were very disappointing, but there may be a silver lining here: essentially, we did very well in the previous two years because we were attracting a relatively narrow range of applicants—the best people in IR/security, but not many others. This year, we had a much more diverse group of students, including—for the first time in memory—a large group of strong applicants in American politics, as well as a much stronger group in comparative politics. We do have a senior offer out in American politics (to Alan Gerber) and the hope is that this appointment will consolidate the group and start to bring in students and not just applicants. In the case of comparative, we made a decision several tears ago to build from below in this field, and we now have a large group of excellent junior faculty. The fact that the group is so heavily junior limits graduate students recruitment. But as reputations grow and positions consolidate, I am confident that these results will change.

Our graduating doctoral students continued to find positions at leading research universities and institutions such as American University, Harvard University, National University of Singapore, University of Southern California, University of Salamanca, Rockefeller Foundation, Stanford University, and the University of British Columbia.

Undergraduate enrollments has trended upward during the past several academic years: 932 in 2000–2001, compared to 808 in 1999–2000 and 777 in 1998–1999; while the number of undergraduate majors has remained fairly constant: thirty in 2000–2001, 27 in 1999–2000 and 38 in 1998–1999. There were 24 minors (Classes of 2001, 2002, and 2003 which has remained flat during the past few years, and 38 concentrators from the Class of 2001. The larger enrollments come from increases among first and second year students, so we are expecting to see an upward trned in minors and concentrators as well. Graduate student enrollment for 2000–01 was 103.

FACULTY

Professor Chandra joined the department this year, and taught in the field of ethnicity and ethnic conflict.

Professor Woodruff was promoted to untenured Associate Professor, effective July 1, 2000.

Roger Petersen, formerly an assistant professor at Washington University in St. Louis, will join the faculty as an untenured associate professor in the Academic Year, 2002. His work focuses on civil and ethnic conflict.

Ed Steinfeld, who had been an assistant professor in the Sloan School of Management, has joined the Political Science Department as an assistant professor. His area of study is Chinese politics.

Assistant Professors Zhiyuan Cui and Susan Giaimo were not promoted to untenured associate professor, and are moving to new jobs elsewhere. Professor Dan Kryder was not promoted to associate professor with tenure, and next year will be his final year at MIT.

Increasing the presence of minorities and women in the department remains a major concern. All three search committees this past year made special efforts to identify outstanding women and minority candidates. The department received and reviewed a total of 132 applications for three open positions. Of those, 36 were women and 22 were probably minorities. Out of four finalists invited to present seminars, one was a woman.

In the coming academic year, the department has decided not to conduct faculty searches. The reasons for this are threefold. The department has a large number of faculty who are on leave during the year thus making a full faculty review of candidates difficult; the department has a very large number of promotion decisions to consider; and, finally, the department has decided to conduct a comprehensive internal review and evaluation of the graduate program and perhaps make some changes in the program if it determines that changes are needed.

Faculty Research

Faculty research activities include:

- Co-director of the Caltech-MIT Voting Technology Project (Professor Ansolabehere)
- Comparative Research on Globalization (Professor Berger)
- CASCON (Computer-Aided System for Analyzing Conflicts) (Professor Emeritus Lincoln Bloomfield).
- Researching discriminatory patterns in the application of employment discrimination laws; exploring problems in the Massachusetts prison system related to a special disciplinary unit within its maximum security facility (Lecturer Burnham)
- "Presidential Approval and Legislative Success" with Scott de March; "The Two Presidencies in the Executive and Budgetary Arenas," with William Howell and David Lewis (Assistant Professor Canes-Wrone)
- Completing book manuscript titled *Why Ethnic Parties Succeed: A Comparative Study,* forthcoming from Cambridge University Press (Assistant Professor Chandra)
- Research on relations between the United States, PRC and Taiwan, and on the impact of alliance relationships on US-China relations (Associate Professor Christensen)
- "The Value of Knowledge," a two year project supported by the Alliance for Global Sustainability; "GSSD-Enterprise," computer-based knowledge sharing and management system, supported by the Sony Development Corp. (Professor Choucri)
- Working on a book manuscript on deliberative democracy; two papers on the place of public and private distinction in democracies are in progress; and currently collaborating with Charles Sabel to develop the implications of their idea of "direct deliberative polyarchy," particularly with regard to the European Union. (Professor Cohen)
- Domestic Politics of War in the United States during the 20th Century; Police and Race Relations in the United States during the 20th Century; and the role of history in current affirmative action and reparations debates (Associate Professor Kryder)
- "The Political Impact of Changing Communication Technologies," Wade Foundation grant, currently focusing on the printing press. "Mexico 2000: Campaigns, Elections and Democratization in Mexico" is a survey research project on campaign effects during the 2000 presidential elections in Mexico City, sponsored by the National Science Foundation (Assistant Professor Lawson)
- "Civic Environmentalism: Ecological, Political and Economic Implications of Local Control" and "Economic and Social Impact of State and Federal Environmental Regulation" (Professor Meyer)
- Book length manuscript on the political uses of "Official Apologies" to indigenous populations in Australia, Canada, New Zealand and the United States (Associate Professor Nobles)
- *Regulatory Diversity among Open Economics: Sources and Implications*, edited with Thomas Bernauer and Hideaki Shiroyama; *Reconciling Efficiency and Equity: On the Incidence and Effectiveness of Compensation*, a book that will examine the role of compensation strategies as mechanisms for offsetting biases toward stalemate (Associate Professor Oye)
- "Technological, Doctrinal, and Training Innovation in the United States Army, 1973–1984" (Professor Posen)

- A book manuscript, *The Promise and Perils of Federalism* will be sent out for review later in the year (Assistant Professor Rodden)
- Third battle of the Atlantic—history of U.S. antisubmarine warfare during the Cold War, *Managing the Cold War*, a book on defense policy and management, the Failed and Successful Public Health Policies (Professor Sapolsky)
- "The Hidden Cost of Electoral Reform: Clean Elections and Voter Disengagement in the Philippines," Fulbright research grant, Spring 2001 (Associate Professor Schaffer)
- "Politics of Climate Change" and "The Political Role of Scientific Cooperation" (Professor Emeritus Skolnikoff)
- "The Incumbency Advantage in U.S. Elections: An Analysis of State and Federal Offices, 1942–2000" (with Professor Ansolabehere), "Legislative Bargaining under Weighted Voting" (with Professor Ansolabehere and Michael Ting), "Malapportionment and bargaining in a Bicameral Legislature" (with Professor Ansolabehere and Michael Ting) (Professor Snyder)
- Caltech/MIT Voting Technology Project, History of Congressional Committees, Speakership election in the U.S. House of Representatives (Professor Stewart)
- "Causes of War: Misperception and the Roots of Conflict" (Associate Professor Van Evera)
- Politics of exchange rate fragmentation; Russia in the international economy (Associate Professor Woodruff)

Faculty Publications

Political Science faculty continue to be prolific publishers of books and articles. Here we provide only an abbreviated listing. Professor Ansolabehere contributed "Equal Votes, Equal Money" forthcoming in *American Political Science Review* and he wrote a report for the Caltech/MIT Voting Technology Project *Voting: What is and What Could Be* (July, 2001). Professor Berger's article "Il Caso Italiano and Globalization" (with Professor Richard Locke) appeared in *DAEDALUS*; Professor Emeritus Bloomfield contributed "The Genetically Engineered Secretary of State" in *Foreign Service Journal*, and his manuscript *Snapshots from the Fringe: Accidental Encounters with History* is scheduled for publication later this year. Lecturer Burnham contributed the chapter "Twice Victimized" in J. Cohen and E. Rogers, eds., *Urgent Times: Policing and Rights in Inner-City Communities*, Beacon Press 1999, and the chapter "Legal Services in Massachusetts" in R. Kass, ed., *Legal Chowder* (forthcoming).

Professor Canes-Wrone's article, "The President's Legislative Influence from Public Appeals" appeared in *American Journal of Political Science*; also "A Theory of Presidents' Public Agenda Setting" was in *Journal of Theoretical Politics*. Professor Chandra wrote "Ethnic Bargains, Group Instability and Social Choice Theory" for a forthcoming edition of *Politics and Society*; in addition she wrote "Elite Incorporation in Multi-Ethnic Societies" for *Asian Survey*, September/October 2000. Professor Christensen published: "China: The Right and Wrong Questions" in *The National Interest*, Winter 2000–2001), with Richard K. Betts and "Posing Problems Without catching Up: China's Rise and Challenges for American Security," *SAIS Policy Forum Series Report*, number 14, December 2000.

Professor Choucri had a number of articles published within the last year, including: "Environmentalism" in *The Oxford Companion to World Politics* 2nd ed, Oxford University Press, 2001 and "Mega-Cities & Global Accords" in *The Future of the City*, F. Moavenzadeh, et. al. eds. Kluwar Publishing (forthcoming). Professor Cohen continues to serve as Editor-in-Chief of *Boston Review*. Three books that he co-edited with Joel Rogers for the Beacon Press New Democracy Forum series appeared this year. Professor Kryder wrote "Reconsidering *An American Dilemma*: War, Statebuilding and the Politics of Black Militancy in the Twentieth Century" *in Total War and the Law: New Perspectives on World War II*, Daniel Ernst, ed., Michigan State University Press, 2001.

Professor Lawson wrote the article "Mexico's Unfinished Political Transition: Democratization and Authoritarian Enclaves" in *Mexican Studies/Estudios Mexicanos* (Summer 2000) and his book, *Building the Fourth Estate: Democratization and the Rise of a Free Press in Mexico*, is due to be published by University of California Press later this year. Professor Locke has co-authored the following books and articles: *Working in America*, with Paul Osterman and Thomas Kochan, MIT Press (forthcoming); *Globalization and Il Caso Italiano*, with Professor Berger, *DAEDALUS* (forthcoming); and "Mirror Images?: Political Strategies for Economic Development in East Germany and Southern Italy" in *Stato e Mercato* (forthcoming). Professor Meyer's article, "Community Politics and Endangered Species Protection," was published in *Protecting Endangered Species in the United State*, eds. Jason F. Shogren and John Tschirhart, (Cambridge University Press, 2001). Professor Melissa Nobles had a book chapter,

"Racial Categorizations and Censuses" published in David I. Kertzer and Dominique Arel (eds.) *Census and Identity: The Politics of Race, Ethnicity, and Language in National Census*, (Cambridge University Press, Fall 2001).

Professor Oye's co-authored the following articles "International Competition: Conflict and Cooperation in Government Export Financing," with Peter Evans, in *The Ex-IM Bank in the 21st Century: A New Approach*, edited by Gary Clyde Hufbauer and Rita M. Rodriguez, Institute for International Economics, Special Report, (January, 2001); "Regulatory Diversity: Can the World Trading System Cope?", edited with Thomas Bernauer and David Victor, *in Swiss Political Science Review, Special Issue, Debate: Consumer Protection in a Global Market*, Autumn, 2000. Professor Posen wrote the chapter "U.S. Security Policy in a Nuclear-Armed World, or What if Iraq had Nuclear Weapons?" that appeared in *The Coming Crisis: Nuclear Proliferation, U.S. Interests, and World Order*, Victor Utgoff, ed. (MIT Press) and his article "Military Operations in Urban Environments: Tactical Realities and Strategic Ambiguities" was included in *Soldiers in Cities: Military Operations on Urban Terrain*, Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2001.

Professor Pye wrote the chapter "Asian Values: From Dynamos to Dominos?" in Lawrence Harrison and Samuel P. Huntington, eds., *Culture Matters: How Values Shape Human Progress* (Basic Books, 2000). Professor Rodden is the lead editor of *Fiscal Decentralization and the Challenge of Hard Budget Constraints*, along with Gunnar Eskelind and Jennie Litvak, currently under review at MIT Press, Economics. Professor Sapolsky wrote the articles "U.S. has a Window to Skip Weapon Generation" with Eugene Gholz in Defense News, Vol. 19 (May 2001) and "Buying Weapons Without an Enemy" in the journal *Breakthroughs (Spring 2001)*. Professor Schaffer's "Might Cleaning Up Elections Keep People Away from the Polls? Historical and Comparative Perspectives" will appear in *International Political Science Review* later this year. Professor Eugene Skolnikoff's article "The Role of Science in Policy: The Climate Change Debate in the U.S." was reprinted in the Spring 2000 issue of *Journal of Liberal Arts*, a Journal on Interdisciplinary Studies of the American College of Thessaloniki, Greece, and in *Review Futuribles*, Paris, France, forthcoming this summer.

Professor Snyder's article "An Informal Rational for Political Parties" (with Mike Ting) is forthcoming in the *American Political Science Review*, and his article "The Effects of Party and Preferences on Congressional Roll Call Voting" (with Professors Ansolabehere and Stewart) is forthcoming in *Legislative Studies Quarterly*. Professor Stewart's book, *Analyzing Congress*, was published by W.W. Norton in 2001. Professor Van Evera published "Primordialism Lives!" in *APSA-CP: Newsletter of the Organized Section in Comparative Politics of the American Political Science Association*, vol.12, (Winter 2001). Professor Woodruff's article "Rules for Followers: Games, Institutional Theory, and the New Politics of Economic Backwardness in Russia," was published in *Politics and Society*, (2000); and he had several book reviews published, including one of "*Power and Prosperity: Outgrowing Communist and Capitalist Dictatorships*" by Mancur Olsen in *East European Constitutional Review* (2001).

The department's faculty continue to give many invited lectures, appear at conferences, serve on boards of professional organizations and editorial boards, in addition to serving as advisors for government, private, and international organizations and agencies. A brief summary is included here. Professor Berger served on the French Ministry of Education's Committee to select tenured professors. Assistant Professor Canes-Wrone attended the Political Economy Research Group's and the Liberty Fund's conferences. Associate Professor Christensen lectured at U.S. Military Academy at West Point. Professor Cohen lectured in Rio de Janeiro at the Conference on Inequality and gave a memorial lecture for Don Kalish at U.C.L.A. Assistant Professor Lawson taught and guest lectured at Harvard and participated in the Salem Speakers Series. Associate Professor Locke lectured at the University of Rio de Janeiro and at Simon Bolivar University. Professor Meyer serves on the editorial board of *International Security* and was a guest lecturer at Tufts Veterinary School.

Professor Nobles received the 2000 Outstanding Book Award for *Shades of Citizenship* from the National Conference of Black Political Scientists and consulted for the World Bank. Associate Professor Oye serves on the Advisory Council of the U.S. Export Import Bank and is a Trustee of the World Peace Foundation. Professor Posen serves as on the editorial board of *Orbis, Security Studies and International Security*. Assistant Professor Rodden presented papers at a World Bank conference and at the U.C. San Diego and organized a conference at Harvard's Center for European Studies. Professor Samuels lectured at Harvard, University of Washington and Ohio State University. Professor Sapolsky lectured at the Center for Strategic and Budgetary Studies and the Royal Institute for International Affairs. Professor Schaffer is the recipient of a grant from the Fulbright Scholars Program and has spent the Spring semester doing field research in the Philippines. Professor Snyder gave seminars at Stanford, Berkley, Yale and Penn.

Associate Professor Van Evera serves on the editorial boards of Journal of *Cold War History*, *Orbis*, and *Security Studies*. Associate Professor Woodruff gave talks at the Centre for Russian and Eastern European Studies (University of Toronto) and at Brown's Watson Institute.

Faculty Leaves

A significant number of faculty are on leave during this coming academic year. Professor Suzanne Berger is on leave for the year, doing research on globalization at L'Ecole Polytechnique in Paris. Assistant Professor Canes-Wrone is on Junior Faculty Research leave in the fall and on leave without pay in the spring, doing research at Caltech. Assistant Professor Chandra is on leave for the year, on a Harvard Academy (Kukin) fellowship. Associate Professor Locke will also be on leave for the year in order to write a book. Assistant Professors Rodden and Associate Professor Woodruff will both be on Junior Faculty Research Leave, in the fall and spring, respectively. Professor Stewart will be on sabbatical in the fall.

We have two visitors, both MIT Ph.D.s, who will help with teaching needs. Serenella Sferza will teach courses on comparative politics, and Annabelle Lever will pick up political theory courses that Stuart White had been teaching.

More information about this department can be found online at http://web.mit.edu/polisci/www/.

Joshua Cohen

COMPARATIVE MEDIA STUDIES

Established as a graduate program in 1999–2000, Comparative Media Studies (CMS) aims to integrate the study of contemporary media (film, television, digital systems) with a broad historical understanding of older forms of human expression. The program embraces theoretical and interpretive principles drawn from the central humanistic disciplines of literary study, history, anthropology, art history and film studies, and aims as well for a comparative synthesis that is responsive to the distinctive emerging media culture of the 21st century. Students in the program are taught to explore the complexity of our media environment by learning to think across media and to see beyond the boundaries imposed by older medium-specific approaches to the study of audio-visual and literary forms.

The comparative and cross-disciplinary nature of both the graduate and undergraduate programs is embodied in a faculty drawn from Art and Architecture, Anthropology, Foreign Languages and Literatures, History, Literature, Music and Theater Arts, Philosophy, Writing and Humanistic Studies, Science Technology and Society, Media Arts and Sciences, and Political Science. Approximately 35 faculty members teach subjects in Comparative Media Studies.

The graduate program consists of a two-year course of study leading to a Master of Science degree. The program aims to prepare students for careers in fields such as journalism, teaching and research, government or public service, museum work, information science, corporate consulting, media industry marketing and management, and educational technology.

RESEARCH

Themes

CMS research themes cross academic disciplines and involve both traditional and emerging communications media, establishing a focus for public presentations, research agendas, and curricular initiatives. The primary research themes are: Creativity and Communication in an Interactive Age; Generation.org—Childhood and Adolescence in a Hyper-mediated Culture; Informed Citizenship and the Culture of Democracy; Global Culture and Media; Media in Transition; and Transforming Humanities Education.

Projects

Over the past year, CMS established a number of research and educational projects. The MIT-Microsoft Games-to-Teach Project, run in partnership with the Learning Sciences and Technologies Group of Microsoft Research through i-Campus, focuses on the interactive, immersive, and narrative potential of digital games as an educational medium. Over the next year, CMS will explore new pedagogical models using games and apply these models to a series of conceptual game prototypes designed to support advanced high school and first-year college science and engineering curricula.

The Meta-Media Archive Project, funded by the d'Arbeloff Award for Excellence in Education, will develop a series of interactive archive models for use across a broader range of topics in the humanities and social sciences. Intended to serve as modules that teachers and students can use to explore rich subject areas, create rhetorical multi-media documents, and collaborate over the Internet. Meta-Media Archives could serve as models for new notions of textbook, research paper, and classroom.

In the Electronic Arts Creative Leaders Workshop series, CMS faculty conduct seminars for producers and other creative developers at Electronic Arts throughout the year. These seminars afford discussion around basic concepts for thinking about the interplay between character, plot, and emotion, drawing examples from both traditional arts (literature, theater, cinema, television, opera) and from contemporary computer and video games.

In addition to these sponsored research and educational programs, CMS will launch a research consortium this fall that explores broader questions under its thematic umbrella. Early consortium members such as FCB Advertising, British Telecommunications, and the World Economic Forum are interested in the complex relationships between people, companies, governments, and nations. Over the next year, research activities will focus on addressing key questions shared by CMS faculty and their commercial, industrial, and political peers.

GOVERNANCE

Professor Henry Jenkins is the Director of Comparative Media Studies. Professor William Uricchio is Associate Director. The program is under the auspices of three Humanities sections: Literature, Writing and Humanistic Studies, and Foreign Languages and Literatures. Administratively, CMS is housed in the Literature Section.

The program is governed by a Steering Committee, chaired by Professor Jenkins. Other committee members for 2000–2001 were: Professor Uricchio; Professor Peter S. Donaldson, Head of Literature; Professor Isabelle de Courtivron, Head of Foreign Languages and Literatures; Professor James Paradis, Head of Writing and Humanistic Studies; Professor of Literature David Thorburn; Professor of French and Film Studies Edward B. Turk; Senior Lecturer in Writing and Humanistic Studies Edward Barrett; and Senior Lecturer in Music and Theater Arts Martin Marks.

During 2000–2001, Comparative Media Studies had four active committees, besides the steering committee: the Curriculum Committee, co-chaired by Professor Thorburn and Senior Lecturer Marks; the Admissions Committee, chaired by Professor Diana Henderson; the Technology and Space Committee, co-chaired by Professor Donaldson and Professor Shigeru Miyagawa; and the Orientation Committee, chaired by Professor Christina Klein.

ADMISSIONS

CMS admitted five students for graduate study in its first year, 1999–2000. The following year, the Admissions Committee selected ten students, eight of whom entered in September 2000 while two deferred admission, until September 2001. This year we received more than 100 applications and admitted ten students. Of the ten CMS students admitted this year, five are women, and six are international students, from Bulgaria, People's Republic of China, England, India, the Czech Republic, and Singapore. This year CMS will realize an important milestone in its development by reaching our target population of 20 students.

Throughout 2000–2001, the program hosted a series of Information Sessions, which were designed to allow potential students to meet CMS faculty and students and evaluate opportunities through the program, and to sit in on classes and workshops. CMS also conducted online chat sessions to facilitate interaction with potential applicants who could not attend theses on-campus sessions; on-line sessions were particularly popular with a growing number of international applicants.

FUNDRAISING

Development activities yielded several major new and continuing sponsored research projects, as well as early members to the MIT Research Consortium in Comparative Media Studies. A primary goal of program activities this past year was to develop and implement sustainable and scalable business, teaching, and research models within which faculty and graduate students could explore interdisciplinary research themes and educational priorities. Grants from the Ford Foundation and Rockefeller Foundation supported a conference on Race in Digital Space in April 2001, which was co-organized by the University of Southern California.

As it continues to solidify its administrative and academic infrastructure, CMS will focus on cultivating a broader range of sponsored research and gifts from corporations, individuals, and foundations in 2001–2002. CMS has laid the groundwork for collaborating with the Office of Campaign Giving, Corporate Relations and Industrial Liaison Program, and Foundation Relations to secure both endowed and expendable gifts. Fundraising events for individual donors are anticipated in Los Angeles, San Francisco, Seattle, New York, Washington, and Boston through May 2002. Regional meetings of the MIT Research Consortium in Comparative Media Studies are expected in London (January 2002) and Chicago (June 2002).

On the international front, CMS has begun conversations with potential partners, corporate sponsors, and individual donors in Europe, Australia, and South America. The program will also reach out to southeast Asia in January 2002 when Professors Jenkins and Miyagawa make their first joint fundraising trips to Japan and Singapore.

UNDERGRADUATE EDUCATION

The undergraduate program—established in 1982 under its former name, Film and Media Studies—serves as preparation for advanced study in a range of scholarly and professional disciplines and also for careers in media or industry. The curriculum consists of more than 50 subjects arranged in three tiers and broadly subdivided into three areas or fields: comparative media, film, and digital studies. Concentrators, minors, joint-majors and majors may specialize in one of these areas or map a coherent combination of subjects across these borders.

CMS is also developing educational and research programs to provide additional opportunities for undergraduates to gain both academic and professional experience in media-related fields. In January, CMS coordinated a weeklong IAP event, "Adapting Linear Storytelling in an Interactive Age," with Sony Pictures Imageworks. CMS also hired five UROP students, for pay and academic credit, to work on research and educational projects like the Electronics Arts Workshops and the Educational Outreach program. In the coming year, CMS is expected to engage more than 20 UROP students in these sponsored research and consortium research activities like the MIT-Microsoft Games-to-Teach Project and the Meta-Media Project.

Current undergraduate student enrollments for the academic years 2000–2003 stand at ten majors, ten minors, and 48 concentrators. The undergraduate homepage is http://web.mit.edu/21fms/www/.

COMMUNICATIONS FORUM

Directed by Professor Thorburn, the Communications Forum sponsors lectures, panel discussions and conferences on all aspects of technology and communications, public policy, and media in transition. The Communications Forum sponsored several panel discussions that attracted a large audience from the academic community at MIT and in the Boston area. Topics included: "New Media and the Elections," "Female Entrepreneurs and Cyberspace," and "Trademark Wars—Corporations and Publics on the Web."

LECTURES, OUTREACH

CMS sponsored weekly colloquia designed to give our graduate students, and the academic community at MIT, a rich and challenging intellectual experience, and opportunities to interact educationally and socially. Topics included: "Deliberating Game Studies -- Pitfalls and Promises of a New Discipline" by Espen Aarseth; "Ceci N'est

Pas Une Jeune Fille: Serious Play, Mimesis and Learning to Grow Up Female" by Dr. Gerry Bloustien; and "Fan Fiction on the Internet: New Venues for Women Writers and Readers" by Sharon Cumberland.

Professor Jenkins also spoke at a wide variety of professional and public conferences and forums, including the: Media Research Council (October 2000; Chicago, Illinois); ACM SIGGRAPH (August 2000; New Orleans, Louisiana); Game Developers Conference (March 2001; San Jose, California); and Pew Charitable Trusts Summit on Cultural Policy (May 2001; Little Switzerland, South Carolina).

CONFERENCES

In 2000–2001, CMS organized three major conferences:

Part of an ongoing series of events focused on creativity in the digital age, the MIT Conference on Digital Cinema (November 2000) brought together filmmakers, critics, and media industry leaders to explore the nature of digital cinema and its cultural significance. The conference combined screenings of significant works in digital cinema with panel discussions centered on such issues as the political consequence of broadening media access, the shifting status of amateur filmmaking, the aesthetics of this emerging media form, and the economics of digital film production and distribution.

We've Wired the Classroom, Now What? (February 2001), a follow-up to the initial *Wiring the Classroom* conference at MIT held in May 1999, was designed to showcase the innovative work of classroom teachers in developing new pedagogical practices in response to the potentials of new media, including the Internet, CD Roms, digital photography; and streaming video and audio. Teachers were able to share their experiences with changing technologies in the educational environment, and to see effective uses of media that could be shared with a larger community.

CMS and USC's Annenberg Center for Communication hosted a three-day conference, *Race in Digital Space*, (April 2000) which explored current issues and celebrated the accomplishments of minorities using digital technologies. Additional information may be found at http://cms.mit.edu/race/.

FACULTY NOTES

Numerous faculty affiliated with Comparative Media Studies published books this year, including: Professor Susan Slyomovics, *Women and Power in the Middle East*, co-edited with Joseph Suad, University of Pennsylvania Press; Professor Irving Singer, *Reality Transformed: Film as Meaning and Technique*, paperback edition, MIT Press; Professor Singer, *Feeling and Imagination: The Vibrant Flux of Our Existence*, Rowman & Littlefield Publishers.

ADMINISTRATION

Alex Chisholm was named Director of Communications and External Relations. Brad Seawell was hired as part-time Administrative Assistant to manage Communications Forum events and conference publicity. Robert J. Bain, Jr. was hired as Senior Editorial Assistant.

In March, CMS consolidated its offices and relocated to new headquarters space in Building 14N, Room 207.

For more information on the Undergraduate and Graduate programs in Comparative Media Studies, contact the CMS Office, 14N-207, MIT, Cambridge MA 02139; telephone 617-253-3599; fax 617-258-5133; e-mail cms@mit.edu. The Comparative Media Studies web site is http://web.mit.edu/cms/.

Henry Jenkins

PROGRAM IN SCIENCE, TECHNOLOGY, AND SOCIETY

2000–2001 was an up-and-down year for the Program in Science, Technology, and Society (STS). On the up-side, several STS faculty members received sizeable grants to support various program activities (including graduate students). The jointly-sponsored History and Social Study of Science and Technology Doctoral Program (HSSST) graduated four new Ph.D.s and had an 83 percent yield on graduate admissions (perhaps the highest at the Institute). Robert M. Metcalfe Professor of Writing Rosalind Williams and Assistant Professor of the History of Science David Kaiser joined the STS faculty and have made auspicious starts.

On the down-side, STS lost the services of Bern Dibner Professor Jed Buchwald and Leo Marx Career Development Assistant Professor of the History and Culture of Science and Technology Jessica Riskin to the California Institute of Technology and Stanford University, respectively. The search for the Bern Dibner Professor and Director of the Dibner Institute ended in stalemate, and the STS Program continues to run a deficit, owing primarily to insufficient four-year funding for entering graduate students. This year HSSST admitted five students, far too few given the number of faculty in STS, History, and Anthropology who want to offer graduate subjects. Numerous graduate seminars end up with only one, two, or three students, simply too small to achieve any sort of critical mass. This problem needs to be rectified by admitting more than the usual four or five students a year.

DOCTORAL PROGRAM

In its thirteenth year, the HSSST Doctoral Program (a collaborative venture of STS, the History Faculty, and the Anthropology Program) continued to develop in a satisfactory way. We are particularly pleased that four HSSST students completed their Ph.D.s. Dr. Eric Kupferberg will be at Harvard University as a Lecturer and Assistant Head Tutor in the Department of History of Science; he will also be a tutor in the Writing Practica at MIT. Dr. Rob Martello has been appointed assistant professor of history at the newly-established Franklin W. Olin College of Engineering in Needham and continues to head the electronic version of the Alfred P. Sloan Foundation-sponsored textbook in American history (see entry for Professor Smith). Dr. Benjamin Pinney has joined the Boston Consulting Group as a consultant. Dr. Eric Sievers is a lawyer with the Institute for Global Communications. HSSST doctoral students Mr. Wen Hua Kuo, Ms. Jessica Eden Miller, and Mr. Kaushik Sunder-Rajan passed their General Exams. Present and incoming students received a variety of grants and fellowships, including fellowships from the Dibner Institute, National Science Foundation (NSF), the Max Planck Institute, the Social Science Research Council, as well as Walter Rosenblith and MIT Presidential fellowships.

The HSSST Doctoral Program received 68 applications for the 2001–2002 academic year. In total, five students accepted, four of our top choices and one alternate. One applicant selected for admission declined our offer and chose Columbia University based solely on the financial package offered by Columbia.

PROJECTS, GRANTS, AND INITIATIVES

Professor Hammonds continues her work with the MIT Center for the Study of Diversity in Science, Technology, and Medicine in the United States with funds provided by the Ford Foundation and the Andrew W. Mellon Foundation ($750,000).

Andrew W. Mellon Professor of Human Development Kenneth Keniston continued his research on cultural aspects of software localization with support from the NEC Corporation (via the Provost's MIT Research Support Committee), the Provost's HASS Fund, and the Mustard Seed Foundation. In addition, he received a grant of $50,000 from the Ford Foundation to organize a working group on "Equity, Diversity, and Information Technology."

Frances and David Dibner Associate Professor of the History of Engineering and Manufacturing David Mindell continues his research on technology, archaeology and the deep sea. In addition, Professor Mindell has received funds to continue his archeological research from a private donor. He is also negotiating with the Italian and Greek agencies to support continuing research in the Mediterranean/Aegean regions.

Leverett Howell and William King Cutten Professor of the History of Technology Merritt Roe Smith received an additional grant of $455,000 from the Sloan Foundation to support the preparation of an electronic edition of the American history textbook he is completing with William R. Kenan, Jr. Professor of American History Pauline Maier (MIT), Professor Daniel J. Kevles (Yale University), and Professor of History Alex Keyssar (Duke University). Total support from the Sloan Foundation for this project now amounts to over $2.2 million.

Abby Rockefeller Mauze Professor of the Sociology of Science Sherry Turkle recently received a grant from the Kapor Foundation ($302,425) to continue the MIT Initiative on Technology and Self.

EDUCATIONAL ACTIVITIES

The STS Program offered 21 undergraduate subjects and 16 graduate subjects. Undergraduate enrollment totaled 384 (fall: 138; spring 246). Graduate enrollment totaled 185 (fall 123; spring 62). Freshman Advisor Seminars were offered by Professors Louis Bucciarelli ("Photovolt. Solar Energy"), Keniston ("Engineers/Careers"), and Fitzgerald ("Viewing the Industrial Revolution in Boston").

There was one undergraduate major, one minor, and 26 concentrators.

New undergraduate classes for 2000–2001 included: STS.063 Children and E-Culture and STS.064 Technology and Identity: Objects, Development, the Life Cycle, both taught by Professor Turkle; STS.042 Einstein, Oppenheimer, Feynman: Physics in the 20th Century, taught by Professor Kaiser and joint with the Physics Department; STS.S26 Factories and Laboratories, taught by Professors Fitzgerald and Hammonds. This freshman subject, containing lectures in addition to numerous field trips, was one of three out of some 40 entries selected to be a pilot class as part of a competition sponsored by the d'Arbeloff Teaching Initiative. (The original proposal was submitted by Professors Fitzgerald, Hammonds, and Mindell.) Professor Keniston's STS.096 Introduction to India prepared ten undergraduates for summer industry and teaching internships in India as part of the MIT India Program which he founded. Professor Hammonds' course STS.047 Medicine, Healthcare, and Society in the US, was officially designated a "communications-intensive" (CI-H) subject in the humanities.

SPECIAL EVENTS

This year's Siegel Prize for the best work by an MIT student in Science, Technology, and Society was awarded to HSSST graduate student Aslihan Sanal. The title of Ms. Sanal's paper is "The Business of Life: Kidneys, Media, Politics and the Privatization of Biomedicine in Turkey and in the Middle East."

In early April the Program celebrated 20 years of service to MIT by Ms. Phyllis Klein, our undergraduate academic officer, by hosting a dinner in her honor. Her position is now ably filled by Ms. Judith Spitzer.

Dr. John Staudenmaier, S.J., was this year's speaker at the Annual Arthur Miller Lecture on Science and Ethics held May 7, 2001. Dr. Staudenmaier is professor of history at the University of Detroit Mercy and Editor of *Technology and Culture* (since 1995). His talk was entitled, "When I say, 'We,' Who is Talking? Ethical Dimensions of Pronoun Usage in Science and Technology Discourse."

COLLOQUIA SERIES AND SPECIAL LECTURES

The STS Colloquia series, headed this year by Assistant Professor of Anthropology and Science and Technology Studies Joseph Dumit and Professor Hammonds, continued to be a core activity of the HSSST doctoral program. This year's series consisted of 15 speakers from such institutions as Columbia, Cornell, Howard, MIT, New York University, and Odense University (Denmark), and covered a wide range of topics including "Sexual Technologies: The Good, the Bad, and the Hard to Believe," "'Building the Fence': On Medical Segregation and Racial Segregation," "A Historian of Technology Confronts the Information Age at MIT," "Syphilis and Segregation: Medical Racism and the Rise of Jim Crow," and "Mapping Disease: The West Nile Virus and Cholera." Professor Smith also organized, with Professor Daniel Hastings, head of MIT's Technology and Policy Program, a lunchtime seminar series for students and faculty in both groups. Speakers in this series included, among others, Professor Alfred Chandler, Harvard University School of Business, Professor Sheila Jasanoff of John F. Kennedy School of Government, and Professor David Hart of the John F. Kennedy School of Government. Professor Smith arranged for informal lunch discussions for HSSST graduate students and faculty by having Dr. Mats Fridlund, Visiting Scholar in STS from the Institute for Future Studies in Stockholm, Sweden, and Professor Arne Kaijser, Dibner Fellow from Royal Institute of Technology, Stockholm, Sweden.

KNIGHT SCIENCE JOURNALISM FELLOWSHIP PROGRAM

Now entering their nineteenth year, the Knight Fellowships continue to attract science journalists from around the world to learn more about the science and technology they cover. During his third year as Director of the Program, Boyce Rensberger organized a week-long intensive fellowship on molecular biology for science journalists, as well as a four-day intensive fellowship on global climate change.

The nineteenth class of Fellows includes Agnieszka Biskup, managing editor, *Muse* magazine; David Chanatry, producer, NBC Weekend Nightly News; Ibiba Don Pedro, environment reporter, *The Guardian*, Nigeria; Carey Goldberg, Boston bureau chief, *The New York Times*; Carol Hills, senior producer, *The World*, BBC and Public Radio International; SeHee Hwang, medical writer, *JoongAng Ilbo,* South Korea; Barbara Moran, freelance magazine writer and television producer; Sean McNaughton, information graphic artist, *The Boston Globe;* Diran Onifade, reporter, Nigerian Television Authority; Rebecca Perry, editorial artist; *The Los Angeles Times*

Fellows attend over 60 seminars with faculty, which are specially organized for them, as well as other seminars and workshops devoted to science and technology and their wider impacts. The Fellowships are supported by an endowment contributed by the John S. and James L. Knight Foundation of Miami and by alumni and foundation gifts. More information about the Knight Science Journalism Fellowships can be found at http://web.mit.edu/knight-science/.

PROFESSIONAL ACTIVITIES

Professor Dumit was a Visiting Professor in the Department of the History of Science, Harvard University, in the spring. He is revising his book manuscript, "Mindful Images: Brain Scans and Personhood in Biomedical America," and co-chaired the STS colloquia series in the fall.

Professor Michael Fischer taught two STS subjects in the fall, as well as tutorials in Anthropology and a class in Comparative Media Studies, served on the STS steering committee and admissions committee, and was on leave in the spring. He participated in three national and two international conferences, was the keynote speaker at one international and one national conference, published two papers, and has two papers in press.

Professor Fitzgerald, Director of Graduate Studies for the HSSST doctoral program, received the Perkins Award for Excellence in Graduate Advising at the Institute Awards Convocation on May 14, 2001. The Frank E. Perkins Award is presented to a faculty member, who as a graduate student advisor, demonstrates unbounded compassion and dedication towards students. With funding from the Provost's Fund, she ran a monthly seminar for Boston area scholars called "Science, Technology, and Agrarian Change." She won, with her colleague Arthur J. Conner Professor of History Harriet N. Ritvo, a grant for $107,000 from the Andrew W. Mellon Foundation for a Sawyer Seminar entitled "Modern Times, Rural Places" for the next academic year.

Associate Professor of Anthropology and Science Studies Hugh Gusterson published the articles "How not to Construct a Radioactive Waste Incinerator" in *Science, Technology and Human Values* and "The Virtual Nuclear Weapons Laboratory in the New World Order" in *American Ethnologist.* He also published op-eds in the *Boston Globe* and the *San Francisco Chronicle.* Professor Gusterson served on selection committees for the MacArthur Foundation and MIT's Knight Science Journalism Fellowship program.

Professor Hammonds was re-elected Secretary of the MIT faculty for a two year term; served on the Council on Faculty Diversity and the Task Force on Minority Student Achievement; served on the search committee for the Dibner chair; served on two promotion and tenure committees; taught four courses; organized departmental colloquia series; organized for the fifth year the Joint MIT/Harvard Workshop on "Race" in the Histories of Science, Medicine and Technology; published one article; worked on two book projects; gave nine invited lectures including three named lectures (Harvard, Radcliffe, and Wellesley); was a Visiting Fellow at the Max Planck Institute for the History of Science in Berlin; served on two NSF review panels in the Social and Behavioral Sciences; served as consultant to Association of American Colleges and Universities and Spelman College; served as consultant on three film projects (two on race and science); served on the History of Science Society Council; served on the Program Committee of the Berkshire Conference of Women's Historians; was elected to Phi Beta Kappa, Spelman College Chapter. Professor Hammonds received a three-year grant from the Mellon Foundation for $750K in July, 2000 to start the MIT Center for the Study of Diversity in Science, Technology, and Medicine. She also received a grant of $190K from the Ford Foundation to organize a National Initiative on Minority Women Scientists and Engineers.

Professor Kaiser published a journal article, two encyclopedia entries, co-edited a four-volume anthology on the history of modern physics (Routledge, in press), presented a paper at a national conference, and delivered four invited lectures throughout the US and Europe. He has also organized and secured funding for a two-part international conference on the history of physical sciences, with 20 participants, to take place at MIT during 2002. A recent article of his was named one of the best articles from 1997–1999 in the history of science by the British Society for the History of Science. He was also awarded the Levitan Prize in the Humanities at MIT, and appointed the Leo Marx Career Development Assistant Professor in the History and Culture of Science and Technology at MIT, for the term 2001–03.

Professor of the History and Philosophy of Science Evelyn Fox Keller completed a book manuscript *Making Sense of Life: Explaining Biological Development with Models, Metaphors, and Machines*, to be published by Harvard University Press next winter, and *The Century of the Gene* (Harvard University Press) was published in October. She was Visiting Professor, Ecole Normale, Fall 2000, Scientist in Residence at the Exploratorium (February), Visiting Scholar at Bellagio (March 16–April 14), and will be Visiting Scholar at Clare Hall at Cambridge University from June through August. In April, Professor Keller delivered a series of lectures as Hannah Lecturer at Hamlin University. She will receive an Honorary Degree from Wesleyan University in May, and was a finalist for the Pen New England Award for *The Century of the Gene*. Two new articles have appeared in edited volumes.

Professor Keniston directed the MIT-India Program, which sent this year 15 students as interns to work sites in India. He traveled and lectured extensively in India, Nepal, and Spain on "Grassroots Information Technology and Development". He has joined the board of the BBVA Foundation in Spain. With an Indian colleague, he is co-authoring a book on "Bridging the Digital Divide, Lessons from India."

Professor Mindell received the MacVicar Faculty Fellowship for undergraduate teaching at MIT. While on leave in the spring term, he completed his book "Between Human and Machine: Feedback, Control, and Computing before Cybernetics" which is in production and will be published by Johns Hopkins next year. He has lectured on this topic at the University of California, Santa Barbara, the University of Pennsylvania, the University of Southampton, and the Explorers Club (Boston). He has spoken on deep sea archaeology at the Monterey Bay Aquarium Research Institute, the University of Southampton Oceanographic Center, MIT On The Road (Paris), the University of Trapani (Sicily), and the MIT Club of Delaware. Professor Mindell arranged a post-doctoral research fellowship for an archaeologist to teach archaeology and study deep ocean technology at MIT, funded by Dr. Anna McCann and the Taggart Foundation. He participated in the Cambridge-MIT workshop on "Cultures of Innovation."

Professor Smith serves as Director of the STS Program and, during the past year, taught two graduate subjects and one undergraduate subject. He continues to head the Sloan American history textbook project, *Inventing America: A Narrative History of the United States*, now in press at W. W. Norton, New York. After 16 years of service, Professor Smith stepped down from the Board of Trustees of the Hagley Foundation. He continues to serve on the boards of the American Museum of Textile History, the MIT Museum, The Thomas A. Edison Papers Project, and the public television series, *The American Experience*. He also continues as Editor of the Johns Hopkins University Press on the History of Technology and presented a paper on "Two Cultures of Innovation in Nineteenth Century America" at a Cambridge-MIT Institute (CMI) workshop in the History of Science and Technology at the University of Cambridge in May.

Professor Turkle received $302,425, renewable for a second and third year, from the Kapor Foundation, to launch an MIT Initiative on Technology and Self dedicated to looking at the social and psychological dimensions of our increasingly intimate relationship with technology. While directing this Initiative she has chaired a conference on adolescence, technology, and identity funded by the Spencer Foundation and continuing activities in this domain of work will be a centerpiece of the activities of the Initiative. Professor Turkle's current research is about the psychological impact of computational objects as they become increasingly "relational" artifacts. She is studying a range of objects, from "affective computers" to robotic dolls and pets.

Professor Williams used her sabbatical leave to complete a book manuscript (tentative title: "Retooling: A Humanist Ponders Changing Technology at MIT") under contract to The MIT Press. She has also given lectures at the Hagley Museum and Cambridge University; worked on shorter publications; and begun to get involved with Program activities in preparation for becoming Director of Graduate Studies on July 1, 2001.

FUTURE PLANS

STS will observe its 25th anniversary in 2001–2002 and is planning two events—one in the fall, one in the spring—to celebrate the occasion. With the departure of Professor Riskin, STS hopes to appoint a new assistant professor of the history of science during the coming year. The Program will also seek to fill the Bern Dibner Professorship of the History of Science. The task of reviewing the graduate program basic courses will continue during 2001–2002. We also have begun a serious review of the undergraduate offerings, and will continue to put into place a more coherent set and diverse range of subjects. We will also continue our efforts to teach and interact with units across the Institute.

More information about the STS Program can be found online at http://web.mit.edu/sts/.

Merritt Roe Smith

CENTER FOR INTERNATIONAL STUDIES

The Center for International Studies (CIS) at MIT is dedicated to generating the knowledge, skills, and leadership necessary to address an increasingly more complex international political and economic environment. CIS focuses on the critical role of international education in science and technology in the transformation and future conduct of foreign affairs and commercial diplomacy. At CIS, we are also seeking new ways that the social sciences, in conjunction with emerging technologies, can be brought to bear on public policy. The quest for this new knowledge, along with a range of unresolved problems—from regional financial crises and nuclear confrontation in Asia to widespread ethnic conflict and structural poverty—are the main forces driving MIT to increase significantly its efforts in internationally oriented research and education. CIS will celebrate its 50th anniversary in 2002.

Richard J. Samuels, Ford International Professor of Political Science and Acting Director of the MISTI Program, joined the center as its new director in July 2000. Simultaneously, Associate Professor Stephen Van Evera began his role as Associate Director. Dr. William W. Keller continued to serve as CIS Executive Director and Research Director of the MIT Japan Program.

This year, CIS established three new programs, described below.

The Program on Human Rights and Justice will play a leadership role in advancing the study of and action on issues of human rights and justice, especially as related to science, technology, and the global economy. It is the first in the United States with a specific focus on these cutting-edge issues. The activities of the program—which has a strong cross-cultural orientation—will include placing interns in inter-governmental organizations, multinational corporations and non-governmental organizations worldwide. It will also administer a fellowship program, a seminar series, and a working paper series. Conferences and research projects will be designed to advance thinking on approaches to the place of rights in securing global justice that are grounded in studies of real-world situations. The program is a joint effort between CIS and the Department of Urban Studies and Planning, and is under the direction of Balakrishnan Rajagopal, Assistant Professor in that department.

The CIS Forums Program will focus public attention on some of the more persistent and lesser-understood problems in world affairs. The first CIS Forum, in January 2001, examined closely the broader consequences of continued unrest in the Middle East for U.S. foreign policy, for the global economy, and for the prospects of democracy in the Arab world. Future forums will address issues related to other aspects of the center's work, including human rights, the U.S. military budget, and forced migration and the internal displacement of refugees. Amy Tarr, who left the directorship of Seminar XXI this year, oversees the Forums Program as Director of Public Programs.

The Program on Political Economy and Technology Policy deploys the analytic methods of political economy to probe public policy issues with significant scientific and technical content. Working with the Technology and Policy Program, CIS seeks to improve both public and private sector responses to emerging technologies. Technological advances often outstrip political, economic and ethical responses to change. This joint project seeks to anticipate consequences of impending technical advances; identify critical areas of uncertainty; suggest near-term actions in light of expected problems/opportunities; and improve adaptation to the unexpected. Working with the Laboratory for Energy and the Environment, CIS seeks to improve responses to environmental problems by:

- Improving public responses to unexpected side effects, options and constraints;
- Examining the role of press, advisory groups, and other institutions in credibly assessing information on issues marked by uncertainty and controversy; and
- Examining the private effects of public environmental policies, with attention to the competitive position of firms, sectors and nations.

Establishment of four additional initiatives—a Program in Humanitarian Studies, a Center for Emerging Technology Policy Studies, the Asia Fellows Leadership Project, and the Crisis Simulation Initiatives Program—will be a CIS priority during the coming year. These programs are described below:

CIS is working with the Harvard School of Public Health and Tufts University to create a certificate Program in Humanitarian Studies. Students from all three institutions will be able to cross-register and participate in the program, which will be centered at Harvard. The initial three years of the program are to be funded by the Mellon Foundation.

The CIS and the Technology and Policy Program at MIT are creating a policy institute to train graduate students to anticipate the impacts of impending technical advances, identify measures to limit likely problems, and exploit emerging opportunities. To be called The Center for Emerging Technology Policy Studies, it will be run by the two organizations, under the joint aegis of the School of Engineering and the School of Humanities, Arts, and Social Sciences.

The Asia Fellows Leadership Project, run jointly by the Security Studies and MISTI Programs, will permit a highly select group of future Asian military, business, and bureaucratic leaders to work closely with Americans who have returned from Asia to continue their scientific and technological studies at MIT. Thus, this is not an Asian Fellows Program, but an Asia Fellows Program, which integrates Asian and U.S. participants. The center will house the Fellows, and will help them define conference, research, and so-called "Track II"—non-governmental, but quasi-official—projects for up to six months in residence.

Since 1993, the Center for International Studies and the MIT Political Science Department have conducted unique political/economic simulation exercises examining the U.S.-Japan relationship and Asian security. In these exercises, teams of experts from academia, industry, and the press assemble to model, through role-playing, the development of political, economic and security affairs in Asia over a 12-year timeframe. Special attention is paid to security issues central to U.S. interests. These efforts have demonstrated the value of political and economic simulations as tools for long-range strategic planning and have won significant notice in the United States and Japan. Recognizing the profound educational value of these exercises, the center plans to institutionalize them by establishing the CIS as an internationally recognized center of simulated learning and creating the Crisis Simulation Initiatives Program.

CIS includes 160 members of the MIT faculty and staff, and visiting scholars from other institutions, many from abroad. It is organized into formal programs such as those mentioned above, working groups, and individual research projects. Programs engage in a broad range of research and training activities related to their substantive concerns. Multidisciplinary working groups bring faculty, research associates, and students together around shared interests. Faculty members and research staff also conduct their own research projects under the auspices of the center.

MIT SECURITY STUDIES PROGRAM

The MIT Security Studies Program (SSP) is a policy research and teaching component of the MIT Center for International Studies. It focuses on the security concerns of states. SSP has over 40 associates, including more than a dozen faculty members who devote essentially all of their professional attention to security issues. About half of the program's faculty members are natural scientists and engineers and half are social scientists, thus giving the program a strong interdisciplinary flavor. Forty-eight graduate students are affiliated with the Program, nearly all of whom are doctoral candidates in political science. In addition, more than 20 fellows are attached to SSP, including military officers from each of the armed services who receive war college credit for time spent at MIT, scientists and engineers from several countries who work on missile defense and nuclear weapons issues, and several senior scholars and former government officials.

Program research is built around the interests of the faculty, the dissertations of the graduate students, and occasional commissioned projects. The research categories are best expressed in a listing of the program's working groups—faculty led research teams that focus on the same general topic. There are seven such groups:

- Asian Energy and Security Working Group—led by Professor Samuels, who directs both the MIT Japan Program and CIS, and Associate Professor Thomas Christensen, a China expert.
- Conventional Warfare Working Group—led by Professor Barry Posen, a political scientist noted for his work on grand strategies, military innovation, and, more recently, ethnic conflict.
- Defense Technologies Working Group—directed by Principal Research Scientist George Lewis, a physicist and one of the Program's Associate Directors, and Professor Theodore Postol, a member of the MIT Science, Technology and Society Program and a nuclear engineer.
- Defense Politics Working Group—chaired by Professor Harvey Sapolsky and Principal Research Scientist Owen Cote, Assoc. Director of the Program, also examines civil/military and interservice relations.
- Future of the Defense Industries Working Group—chaired by Professor Sapolsky, focuses on life after the Cold War for defense contractors and arsenals in both Europe and the United States.

- Humanitarian Intervention Working Group—offered jointly with Harvard and chaired at MIT by Professor Van Evera, a member of the Political Science Department and an international relations theorist.
- Space Policy Working Group—led by Professor Daniel Hastings of the MIT Aeronautics and Astronautics Department and former Chief Scientist of the Air Force.

Each year the program sponsors four to six conferences including a conference jointly organized with Harvard (The Future of War), an annual conference on airpower topics named after MIT graduate General Jimmy Doolittle (USAF), and another on nuclear weapons named after Vice Admiral Levering Smith. Summaries of program conferences are widely distributed.

In addition to conference summaries, the program publishes a research journal, *Breakthroughs*; a seminar summary series, "SSP Seminars"; a monthly newsletter, *Early Warning*; and a working paper/occasional paper series. These are distributed via the Internet and a large mailing list. Several *Breakthroughs* articles have been reprinted by other publications and several working papers have been adopted for courses at other universities.

MIT INTERNATIONAL SCIENCE AND TECHNOLOGY INITIATIVE (MISTI)

MISTI creates and supports programs that promote the internationalization of education and research at MIT. MISTI/China was launched in 1994, the first of a projected series of regional programs to enhance the ability of MIT students to acquire a deeper understanding of how knowledge is created and used in other countries. It also provides opportunities for MIT researchers to develop international collaborations with scientists and technologists at outstanding foreign institutions.

The principal objective of these collaborations is to expand core resources for studying other societies on campus and to share a growing MIT base of knowledge about foreign science, technology, and industry through outreach programs in the United States. Today MISTI has three programs in Asia: China, India and Japan, and three in Europe: Germany, Italy and France. The mandate of all the programs is to educate MIT scientists, managers and engineers in the language and culture of the country before placing them in "hands on" internship situations in the host country. The internship program has two primary objectives: to launch students in their careers by fostering international skills and expertise, and more broadly, to develop a cadre of internationalists—specialists in technology and management—who can strengthen interaction and communication with Japan and East Asia.

The programs also conduct meetings, symposia, workshops and produce and disseminate research on pertinent topics. MISTI works closely with sponsors on all the above programs and produces a biannual resume book.

MIT CHINA PROGRAM

China was the first focus of the MISTI Program, offering opportunities for student internships in mainland China, Taiwan, and Hong Kong. Students work at public service organizations, laboratories, and multinational corporations in Greater China. The program also facilitates collaborations between MIT and outstanding Chinese universities and laboratories. Students are placed in diverse host institutions such as Tsinghua University, Fudan University, Intel Corporation, IBM, Microsoft, Roche Pharmaceuticals, General Motors, the United Nations, the World Wildlife Fund and many others. More than 50 MIT students are now sent to Greater China on internships each year.

MIT-CHINA EDUCATIONAL TECHNOLOGY INITIATIVE

In 1997, MISTI sponsored a new student internship program: The MIT-China Educational Technology Initiative (MIT-CETI). The mission of MIT-CETI is to build cross-cultural understanding between Chinese and American students through the development of computer-related educational projects. Five teams of three MIT students are sent to Chinese high schools each year for six-week summer projects. Since President Clinton's visit to a CETI internet project in China in 1998, the CETI curriculum has expanded into other technical areas such as web design, desktop editing, digital imaging, robotics, biotechnology, and e-commerce.

MIT FRANCE PROGRAM

The MIT France Program started in September 2000, as the sixth country program of the MIT International Science and Technology Initiatives (MISTI). Built on the MISTI model, the MIT France Program aims to bring understanding of the accomplishments and problems of contemporary France to the attention of the students and

faculty of MIT. In order to build long-term networks of cooperation between MIT and France, the MIT France Program is setting in place three main components:

- Internships for students and recent graduates in companies and research laboratories in France: for the first year of the program, 17 students have been placed in France. An additional five MIT students will study in France in 2001–2002.
- Doctoral and postdoctoral fellowships for young MIT researchers to conduct research in France's leading laboratories
- Visiting positions for French professors or researchers in various MIT departments

With recent support from the French Ministry of Foreign Affairs (FMFA), the MIT France Program will add a fourth component: jumpstarting new collaborative projects between MIT and France which encourage multidisciplinary approaches in education, research and technological innovation

MIT GERMANY PROGRAM

In 1996, MISTI launched the MIT Germany Program. It provides internship opportunities for undergraduate and graduate students to combine their knowledge of German language and culture with their expertise in the fields of engineering, science, and management. Sending about 40 students each year, the program has placed about 200 MIT students in German companies, research and government institutions including BMW, Bosch, DaimlerChrysler, Infineon Technologies, Siemens, the Max Planck Institute, and the German Parliament. It has also placed about 30 Visiting Students from Germany in MIT labs for short-term research stays. In 2000 the MIT Germany Program Consortium was founded consisting of a select group of sponsors with whom program cooperation goes beyond the internship component. With this group the MIT Germany Program organizes workshops, lectures and recruiting events.

MIT INDIA PROGRAM

The MIT India Program sends MIT graduate and undergraduate students to India for industry, research, and teaching internships, enabling these students to gain direct experience of Indian life, science, business, and technology. Established through a pilot project in the summer of 1998, the program has sent 38 students over the past three years. In 2001, fourteen students are interning in the areas of finance, education, chemical engineering, mechanical engineering, local uses of technology, computer programming and development, and telecommunications. Host institutions for 2001 include GE's John F. Welch Technology Centre (Bangalore); Hikal Ltd. (Mumbai); ICICI Ltd. (Mumbai); Infosys Technology Ltd. (Bangalore); the Kalmadi Shamarao High School (Pune); Tata Steel and the Rotary Club of Jamshedpur (Jamshedpur); and the Telecommunications and Computer Networks Group at IIT Madras (Chennai).

MIT ITALY PROGRAM

In 1998 MISTI launched the MIT Italy Program, modeled on the MIT Japan Program. It provides internship opportunities for undergraduate and graduate students to combine their knowledge of Italian language and culture with their expertise in the fields of engineering, science, and management. The program has already placed 20 MIT students in Italian research institutions, companies, and government ministries. In the fall of 2001, it will hold its first international symposium in Italy.

MIT JAPAN PROGRAM

The MIT Japan Program was established in 1981 and is the largest, most comprehensive program of its kind in the country. It routinely places MIT interns in Japanese laboratories after preparing them at MIT with two years of language and with courses on Japanese culture and history. The program currently sends between 30–40 interns to Japan each year. Since its inception, the MIT Japan Program has sent more than 700 student interns to Asia. Today, more than half of those students are working with U.S. corporations. The program also conducts workshops, symposia and meetings, bringing together U.S. and Asian academics, government organizations, and corporations to address critical issues that arise in the areas of international science, technology, and management. Participants form networks to enhance understanding and effectiveness between the Japanese and U.S. science, technology, and business communities.

Program sponsors place these bilingual, bicultural professionals in key positions in Japan, America, and East Asia to facilitate communication and to acquire technologies and management expertise. As their companies seek new

opportunities in a dynamic Asian environment, many former MIT interns play a strategic role in creating networks that aid in the development of business partnerships and joint ventures.

THE INTER-UNIVERSITY COMMITTEE ON INTERNATIONAL MIGRATION

The Inter-University Committee on International Migration draws on social science faculty, scholars, and students from MIT and the Cambridge-Boston academic community to study salient issues of developing countries. With a multidisciplinary training and research agenda, the committee sponsors workshops, interdisciplinary research teams, and individual scholarly efforts in a variety of substantive areas.

INTERNATIONAL MIGRATION

CIS works closely with the Inter-University Committee on International Migration, established in 1974. This committee brings together faculty members and research scholars from Boston University, the Fletcher School of Law and Diplomacy, Harvard, MIT, Tufts University, and Wellesley College concerned with migration and refugee studies.

With a grant from the Mellon Foundation, the committee runs two year-long seminar series (at MIT and Tufts) and implements the Mellon-MIT Inter-University Program on Non-Governmental Organizations (NGOs) and Forced Migration, which provides competitively-awarded small grants for faculty, graduate students, and research scholars at member institutions to conduct research on this topic. Each year, CIS hosts a staff member of the Office of the United Nations High Commissioner for Refugees who participates in the work of the Inter-University Committee on International Migration. In 1998 the committee initiated the Rosemarie Rogers Working Paper Series with the publication of the study, "Missed Opportunities: The Role of the International Community in the Return of the Rwandan Refugees from Eastern Zaire," by Joel Boutroue of UNHCR. A total of eight working papers have been published in the series, and another two are in press. Studies by Mellon-MIT grantees are published in this series, or in the *Mellon Reports* Series.

DEMOGRAPHY, ETHNICITY, SECURITY

With support from the Smith Richardson Foundation, CIS is completing a project on demography and security. Ten studies were commissioned for a workshop held at the Center in late 1998 on the political consequences of demographic changes and the security implications of state policies to change demographic variables. Two books emanating from the project are being published in July 2001 by Berghahn Books. The first is a volume of essays co-authored by the late Professor Myron Weiner and Dr. Michael Teitelbaum (Alfred P. Sloan Foundation) entitled *Political Demography, Demographic Engineering*. A second, containing the studies commissioned for the workshop, is entitled *Demography and National Security*, edited by Professor Weiner and Dr. Sharon Stanton Russell (CIS). Both volumes are forthcoming in 2002.

The Project on Race, Ethnicity and Censuses, conducted by Associate Professor Melissa Nobles (Political Science), examines the historical development of contemporary political battles over racial census categorization in the United States and Brazil. Both countries have long histories of immigration, both voluntary and involuntary, that are reflected in the categories and uses of census data. A conference at CIS, funded by the Sloan Foundation, brought together scholars in the field. Professor Nobles' completed study, *Shades of Citizenship: Race and Censuses in Modern Politics*, was published in 2000 by Stanford University Press.

DEVELOPMENT PROJECTS, SEMINARS, AND COLLOQUIA

The Joint Faculty Seminar on Political Development (JOSPOD), founded in 1964, is co-sponsored by the MIT Center for International Studies and the Harvard Weatherhead Center for International Affairs. Suspended in 1999, JOSPOD will resume in 2001. The Migration Seminar Series of the Inter-University Committee on International Migration, chaired by Dr. Stanton Russell, explores the factors affecting international population movements and their impact upon sending and receiving countries and relations among them. The Mellon-MIT Inter-University Program on NGOs and Forced Migration conducts The Mellon Presentations series throughout the year featuring the work of persons who have received grants from the Mellon-MIT program. Peoples and States: Ethnic Identity and Conflict, chaired by Professor Jean Jackson (Anthropology), examines the issues of ethnic and nationalist identities in relation to the state. The Emile Bustani Middle East Seminar, a guest lecture series organized by Dean Philip Khoury (History and CIS), focuses on issues of peace, conflict, and democratization in the Middle East and North Africa.

The MacArthur Transnational Security Seminar, co-sponsored by the MIT Center for International Studies and Harvard's Weatherhead Center for International Affairs, was initiated in 1996 with a grant from the John D. and Catherine T. MacArthur Foundation. Women and International Development (WID), a program jointly sponsored by the center and the Harvard Institute for International Development, conducts seminars and workshops that address issues relating to women and international development.

CROSSCUTTING WORKING GROUPS

In addition to these formal programs, CIS research is conducted via crosscutting projects typically organized as working groups. Because many pressing international issues do not fit neatly within functionally or regionally defined category, center working groups link CIS programs to one another, to other groups within MIT, and to many outside institutions. Several of these groups are structured to link the efforts of social science professionals with those of engineers and natural scientists on problems of academic and policy significance. Examples of active CIS working groups include:

- The MacArthur Foundation Transnational Security Project
- The Working Group on Nuclear Waste and Proliferation
- The Working Group on Asian Innovation and Crises
- The Asian Energy and Security Working Group
- The Uncertainty and Regulation Working Group
- The China Environment Working Group

POLITICAL ECONOMY, ENERGY AND ENVIRONMENTAL STUDIES

The Center for International Studies offers a variety of research and training programs on connections between politics and markets. One cluster of activity centers on national adaptations to a global economy, while a second cluster centers on security and environmental costs that may be external to markets. The activities described below include individual and collaborative faculty and student research, fellowship programs, and several workshops and seminar series. In addition, the center maintains an ongoing grant program for research on international energy and environmental policy. These are areas marked by controversy, and CIS faculty, research associates and students address problems in political economy, energy and environmental studies from an exceptionally broad range of perspectives.

NATIONAL ADAPTATIONS TO A GLOBAL ECONOMY

Several projects and series examine national adaptations to an increasingly global economy, with attention to the economic and political implications of increasing integration of goods, technology, and capital markets.

The Harvard-MIT Joint Working Group on Transnational Economic Security examines the effects of globalization on the demand for private and public adjustment initiatives and the financial capacity of firms and governments to facilitate adjustment. Further, it looks at firm and governmental incentives to alter taxation, environmental regulations, and labor standards. It is supported by the John D. and Catherine T. MacArthur Foundation.

RESPONSES TO SECURITY AND ENVIRONMENTAL EXTERNALITIES

A second set of projects centers on how security and environmental costs external to markets might best be addressed. Debates over these issues break out into two broad positions. One line stresses potential causes of market failure, then turns to associated public policy responses. A second line stresses potential causes of regulatory failure, then turns to associated proposals for regulatory reform and/or deregulation. The research activities by CIS faculty and affiliates along these two lines are described below.

Asian Energy and Security Working Group

Michael Lynch continued his work with a team drawn from the Security Studies Program, MISTI and the Japan Program. They are examining security externalities associated with energy and infrastructure choices and to evaluate economic and military strategies for addressing these energy externalities. This group has been funded by the CIS innovation fund and by NEDO.

International Aid and Chinese Coal Combustion Projects

Two teams drawn from the departments of political science, urban studies and planning, chemical engineering, and the technology and policy program are examining local and international responses to Chinese coal combustion.

These CIS joint projects with Tsinghua University, Taiyuan University of Technology, Tokyo University and the Swiss Federal Institutes of Technology (ETH) have been supported by the Center for Global Partnership, the Alliance for Global Sustainability, NEDO, and ABB.

Uncertainty and Environmental Decisionmaking
CIS Research Affiliates James Foster and former NRC Policy Division Director Lawrence McCray have been leading working groups on regulatory adaptation and on the credible assessment of scientific and technical information. Faculty members Assistant Professor Brandice Canes-Wrone, Dr. Joanne Kauffman, Associate Professor Kenneth Oye, Professor Sapolsky, and Professor Emeritus Eugene Skolnikoff have been participants in conferences and workshops. These activities have been supported by the Consortium on Environmental Initiatives.

WASHINGTON ACTIVITIES

The Center for International Studies operates three programs that focus on training and public policy-making. These are addressed to the military and intelligence communities, the State Department and Foreign Service, and to senior Congressional Staff.

Seminar XXI—Foreign Politics, International Relations and the National Interest—is an educational program for senior military officers, government officials, and executives in the national security policy community. Its fundamental objective is to provide future leaders of the national security policy community with enhanced analytic skills for understanding foreign countries and the relations among them. Fellows learn to raise new questions and to recognize assumptions that underlie assessments of foreign societies confronting them as policymakers. The seminar explores key policy issues by examining countries and problems critical to American interests through a variety of paradigmatic lenses. At each session, eminent experts present alternative perspectives from which the given country or problem can be understood. The seminar seeks to provide concrete frameworks for examining how different paradigms suggest fundamentally different, even conflicting, answers to the questions American policymakers must resolve. In June, Amy Tarr, Director of the Seminar XXI Program since 1997, took a new position at CIS as Director of Public Programs. Marsha Bolton, previously of SSP, was promoted to Director of the Seminar XXI Program.

American diplomatic trainees of varying rank participate in the Kalker Seminars on American Foreign Policy, a series of workshops dealing with critical issues in global affairs. The series brings together distinguished faculty from American and foreign institutions along with high-level State Department and other government officials. Each month diplomatic trainees focus on an in-depth discussion of major issues and American strategies appropriate to a turbulent contemporary global environment. Seminars are held at the State Department's Foreign Service Institute in the Washington, DC area.

The annual Congressional Senior Staff Seminar provides intensive briefings on a selected issue in science and technology policy for senior members of congressional staff. In 2001, the seminar examined issues concerning defense technology, and was held at Lincoln Laboratory.

WORKSHOPS, LECTURES, AND SEMINAR SERIES

The Center for International Studies hosts a variety of workshops, lectures, and seminar series, many of which are open to the Boston area academic community and the public. A list of CIS lectures and seminars follows:

- CIS Forum Series (The IAP Forum on the Middle East), new in 2001
- Program on Human Rights and Justice Forums, new in 2001
- The Emile Bustani Middle East Seminar
- The Security Studies Program (SSP) Seminars
- The MIT/Harvard Future of War Seminar
- The Star Seminars
- General James H. Doolittle Workshop and Dinner
- Admiral Levering Smith Seminars
- The Seminar on Global Accords for Sustainable Development
- The MIT Japan Technology Forum Lecture
- Inter-University Seminar on International Migration
- Kalker Seminars on American Foreign Policy
- The MacArthur Program on Transnational Security
- Lecture Series on Gender and Politics

GRANT PROGRAMS

The Center for International Studies administers a variety of fellowships for social science doctoral students at MIT. Three are administered directly by the Center for International Studies: The Mellon-MIT Inter-University Program on NGOs and Forced Migration Research Grants; the International Energy and Environment Policy Research Grants; and the MacArthur Transnational Security Research Grants.

In addition to these, CIS serves as the point of contact for three national competitions: the SSRC/International Predissertation Fellowship; the Luce Foundation Fellowships (also open to seniors, recent alumni, and junior faculty); and the National Security Education Program (NSEP).

During 2000–2001, CIS provided substantial support for approximately 15 graduate students from several departments through these fellowship programs, in addition to the internships provided via MISTI and MIT Japan for undergraduates.

PUBLICATIONS

Several new CIS publications were produced this year. Principal Research Scientist Cindy William's *Holding the Line; U.S. Defense Alternatives for the Early 21st Century* was published by the MIT Press in February 2001 and was launched at a press conference at the National Press Club in Washington, DC.

Professor Samuels and Dr. Keller published working papers based on research for their upcoming co-edited volume, *Innovation and Crisis: Asian Technology after the New Millennium.* The papers appeared in May 2001 in the new MIT Japan Working Paper Series.

In addition to the publications of the Security Studies, Japan and MISTI Programs, the center publishes a biannual newsletter, *Precis*, and several working paper series. These include CIS Working Papers, the Rosemarie Rogers Working Paper Series (formerly the Migration Working Paper Series), the MacArthur Transnational Security Working Papers, and the Mellon-MIT Program Working Paper Series.

PERSONNEL

Many new staff members were welcomed in 2001, including Robert Murray (Administrative Officer), Quan Mong Quan, Sean Gilbert, Sylvan Ferrari, and Makiko Okuma (MISTI Program), and Marie Senat-André (Headquarters Financial Assistant). CIS was also pleased to announce two internal promotions: Marsha Bolton (SSP) was promoted to Executive Director of the center's Seminar XXI Program. Amy Tarr, previous director of Seminar XXI, was promoted to the new position of Director of Public Programs. From the SSP Program, Owen Cote, George Lewis, and Cindy Williams were promoted to the rank of Principal Research Scientist. CIS draws personnel from the MIT faculty and student body and recruits through the MIT Personnel Department. Our personnel reflect the general commitment of MIT to affirmative action goals.

More information about this center can be found online at http://web.mit.edu/cis/.

Richard J. Samuels, William W. Keller

PROGRAM IN WOMEN'S STUDIES

Women's Studies continues to build on its success as an interdisciplinary undergraduate program, and provides a framework and community for scholarly inquiry focusing on women, gender and sexuality. Exploring the places of gender cross-culturally, historically, and artistically, Women's Studies subjects strive to help MIT students better understand various constructions of knowledge and value, and to realize the range of personal and intellectual discoveries made possible by using gender as a category of analysis. The program is also an important resource and support for faculty with an advanced knowledge of gender studies within particular disciplines but interested in learning more across disciplinary lines; moreover, it welcomes faculty who have an emerging interest in the field of Women's Studies.

PROGRAM ADMINISTRATION

During 2000–2001, the program was directed by Margery Resnick, Associate Professor of Hispanic Studies. During academic year 2000–2001, the Women's Studies Steering Committee consisted of Associate Professor Sally Haslanger (Philosophy), Professor Jean Jackson (Anthropology), Associate Professor Anne McCants (History), Professor Ruth Perry (Literature), Professor Resnick (Chair), Professor Susan Slyomovics (Anthropology), and Associate Professor Elizabeth Wood (History). Ex-officio members of the steering committee are: Associate Head Librarian and Collections Manager for Women's Studies Marlene Manoff (Humanities Library), and Women's Studies Program Coordinator Michèle Oshima. The Curriculum Committee consisted of Professor Haslanger, Associate Professor Diana Henderson (Literature), Professor McCants (Chair), and Assistant Professor Christine Walley (Anthropology). The Programming Committee consisted of Visiting Associate Professor Odile Cazenave (Foreign Languages and Literatures), Professor Isabelle de Courtivron (Foreign Languages and Literatures), Professor Henry Jenkins (Literature and Comparative Media Studies), Professor Perry (Chair), Professor Slyomovics, and Professor Wood. The Advisory Committee consisted of Professor Ellen Harris (Music), Professor Nancy Hopkins (Biology), Professor Molly Potter (Brain and Cognitive Science), Professor Bishwapriya Sanyal (Department of Urban Studies and Planning), and Professor Robert Silbey (Chemistry).

CURRICULUM

The Program in Women's Studies offers an undergraduate curriculum consisting of core classes and cross listed subjects from several departments. Students may concentrate, minor and petition for a major departure in Women's Studies. The Program in Women's Studies offered thirty subjects during the academic year 2000–2001, with approximately 400 students enrolled. The curriculum was enriched by the following four new subjects taught by faculty in several units: "Contemporary U.S. Hispanic Literature and Film: Lives in Translation" (Associate Professor Nicolas Wey-Gómez, Foreign Languages and Literatures), "Studies in Poetry: Gender and Lyric in the English Renaissance" (Associate Professor Mary Fuller, Literature), "Women and the Avant-Garde" (Professor Cazenave, Foreign Languages and Literatures), and "Women and Global Culture: Representations of Gender, Race, and Class in Contemporary African Film" (MLK Visiting Scholar Tsitsi Dangarembga, Foreign Languages and Literatures). Women's Studies had two majors this year. Professors Haslanger and Wood advised one student on her Women's Studies thesis research. The other major chose the new option of a two-subject substitution in lieu of a thesis. The curriculum has expanded to such an extent that Professor McCants and Program Coordinator Michèle Oshima overhauled the subject numbering system to allow for continued growth. In addition, Professor Haslanger was the representative for the program to the Graduate Consortium in Women's Studies (GCWS) which she co-chaired. This year, the GCWS offered three graduate level courses and a dissertation workshop, in which one MIT graduate student enrolled.

PROGRAMMING HIGHLIGHTS 2000–2001

Women's Studies programming reflects the wide spectrum of issues and disciplines involved in the program. Especially given the absence of an Institute-wide Women's Center, many groups and programs also seek our co-sponsorship of events. In keeping with the interdisciplinary and often holistic educational focus of our field, Women's Studies was pleased to sponsor the following events this year.

The program sponsored the McMillan-Stewart Lectures on Women in the Developing World: "Pathways to Human Rights in Morocco" a talk by Fatna Elbouih, Moroccan human rights activist and former political prisoner; and "They'll kill me and I won't see New York again" Turkish architect, filmmaker and former political prisoner Feride Cicekoglu. In conjunction with the Ms. Cicecoglu's lecture, Women's Studies and the International Film Club cosponsored a screening at MIT of *Journey of Hope*, for which she wrote the screenplay.

Political Science Lecturer Margaret Burnham reported on her fact-finding tour of Israel/Palestine (specifically West Bank, Gaza, Jerusalem, Tel Aviv, Bethlehem, Nazareth, and Hevron).

"Whose Human Rights in Africa? an Interdisciplinary Dialogue on Gender and Power" panel featuring Monique Ilboudo, secretary of human rights in Burkina Faso and novelist, Paula Fray, editor for the Saturday Star in Johannesburg, South Africa, and current Neimann Fellow at Harvard, and Moroccan activist and former political prisoner Fatna Elbouih, was moderated by Professor Burnham and cosponsored with Political Science.

"Gender and Human Rights in Africa through the Arts" panel featuring Monique Ilboudo, novelist from Burkina Faso involved in the Rwanda project, Veronique Tadjo, Ivory Coast author, painter, and poet on recent work in Rwanda, Anne-Laure Folly, Togolese documentarian on making documentaries on women, and Tsitsi Dangarembga, Zimbabwean author and filmmaker on her experence there, moderated by Professor Cazenave and cosponsored with the Office of the Arts and Comparative Media Studies.

African Film Festival cosponsored with the African Students Association, International Film Club, FL&L, and CB/BS featured screenings of *Guelwaar* (Ousmane Sembene, Senegal, 1992), *La Vie est Belle* (Mweze Ngangura and Benoît Lamy, Belgium/Congo, 1987), *La Petite Vendeuse de Soleil* (Djibril Diop Mambety, Senegal, 1999), *Sango Malo* (Bassek Ba Kobhio, Cameroon, 1991), documentary *Women of Angola* aka *Les Oubliees* (Anne-Laure Folly, Togo, 1997), and *Everyone's Child* (Tsitsi Dangarembga, Zimbabwe 1996).

Women's Studies co-sponsored the Center for Bilingual/Bicultural Studies program "Bilingual, Bicultural, and Biracial Identity and Creativity in Contemporary Africa" panel featuring Tsitsi Dangarembga, Anne-Laure Folly, and Veronique Tadjo moderated by Professors Cazenave and de Courtivron.

MIT Poetry Slam emceed by Lisa King, featured guest poet Letta Neely and was cosponsored by MIT Program in Women's Studies, DeFlorez Fund for Humor, Student Life Now, and the Council for the Arts. Prior to the event, Women's Studies and the International Film Club cosponsored a screening of *Slam Nation* and residence-based poetry presentations at pika, East Campus, ADP, and La Casa. This momentum led to additional spring events: Ill Vibes at Chocolate City; the MIT Poetry Slam team creation; and the MIT Poetry Slam-Off emceed by Gavin Greer. The MIT Team squared off against three teams from the community: The Cantab, Lizard Lounge, and Worcester.

"Tres Vidas" was the world premiere of a new chamber music theater work for singing actress and chamber music trio (The Core Ensemble). The piece is based on the lives of three legendary Latin American Women: renowned Mexican painter Frida Kahlo, Argentine poet Alfonsina Storni, and Salvadoran peasant-activist Rufina Amaya. Cosponsored with the Office of the Arts and Music and Theater Arts.

"Dancing Through Disruptions: Notions of 'Classical Antiquity,' Postcolonial Fractures, and Complex Footwork," Dr. Ananya Chatterjea, a prominent dance theorist and practitioner on the faculty of the Department of Theater Arts and Dance at the University of Minnesota was cosponsored by the Council for the Arts at MIT, Women's Studies, and Theater Arts.

"Making the Workplace Family-Friendly: Who is Responsible?" a panel featuring speakers Kathy Cassavant, Secretary-Treasurer, Massachusetts AFL-CIO Kathy Hazzard, former HR Manager, John Hancock Financial Services and currently independent consultant on employers and domestic violence Lois Shaevel, Work/Life and Diversity Manager, MBTA was moderated by Lecturer Mindy Fried (Women's Studies) and cosponsored by Women's Studies and the Kelly-Douglas Fund.

A series of events on welfare included: "The Politics of Welfare Reform" with Representative Ann Paulsen and Diane Dujon; and "Reclaiming our Lives, our Voices: Women's Experiences of Poverty, Welfare, and New Beginnings" a panel of former welfare recipients moderated by Lecturer Manjari Mehta (Anthropology).

"Feminism at the Millennium" a talk by Katha Pollitt was cosponsored by New Words, a Women's Bookstore.

"The Political Aesthetics of Destruction: Re- Presenting Beirut, 1975–1995" by Miriam Cooke was cosponsored with History, Theory and Criticism, Anthropology Program, and the Aga Khan Program for Islamic Architecture.

"New Environmental Initiatives and Gender: An Analysis of Community Forestry in South Asia" talk by Bina Agarwal on Environmentalism was cosponsored with the Department of Urban Studies and Planning.
"The Rights Attack on Affirmative Action" Jean Hardisty, President and Nikhil Aziz, Research Analyst, both of Political Research Associates an independent not-for-profit research center.

Women's Studies provided the on-campus publicity for the groundbreaking *Race in Digital Space* three-day conference on identity in the digital realm. This was collaboratively produced by the University of Southern California, MIT, the University of California at Santa Barbara and New York University through the Comparative Media Studies Program. More information about this conference can be found online at http://cms.mit.edu/race/.

Women's Studies co-sponsored several of the Comparative Media Studies colloquia: "Fantastic Voyage: Fluidity and Blurred Boundaries in Men's Fantasies with Pornography" Mike Putnam; "Ceci N'est Pas Une Jeune Fille: Serious Play, Mimesis and Learning to Grow Up Female" Gerry Bloustein, Australian feminist ethnographer/videomaker; "Fan Fiction on the Internet: New Venues for Women Writers and Readers" Sharon Cumberland; "Anime Identities: Japanese Anime and the American Audience" Susan Napier, a visiting scholar at Harvard. In addition, Women's Studies cosponsored the following Communications Forums: "Intellectual Property and the Internet" primary speaker Rosemary Coombe, a feminist anthropologist, and "Female Entrepreneurship" Marney Morris, the founder of Animatrix, a leading web design studio, and Denise Brosseau, the founder of the Forum for Women Entrepreneurs.

"Queer Diasporas, Psychic Diasporas: Space and the World of Wong Kar Wai" by David Eng, Visiting Professor at Harvard (on leave from Columbia), was cosponsored by Women's Studies, Comparative Media Studies, Literature and Foreign Languages and Literatures. Screenings of *Chungking Express* and *Happy Together* in conjunction with this talk were cosponsored by MIT Program in Women's Studies and the International Film Club.

Women's Studies cosponsored Loni Ding's discussion of her films and the screenings of her documentary film series "Ancestors in the Americas" Part I: Coolies, Sailors, and Settlers: Voyage to the New World and Part II: Chinese in the Frontier West: An American Story, with Counseling and Support Services, and the Campus Race Relations Committee.

Screening of *Gendernauts* by Monika Treut was cosponsored by MIT Program in Women's Studies and Comparative Media Studies.

Women's Studies cosponsored the IAP oversubscribed subject "Home Repair for Women: Electrical Work" led by Bev Stohl, Ri Romano and Joe Fagone with ESG.

Women's Studies cosponsored the workshop: "Asian Girl Chronicles/Exploration through Photography" led by Carolyn Chen. The results of the workshop were "The Asian Girl Chronicles display in Lobby 10" and "The Asian Girl Chronicles reception/discussion" both of which were supported and made possible by MIT Council for the Arts, Campus Committee on Race Relations, Women Studies, Theater Arts, Architecture, Comparative Media Studies.

RESEARCH, PUBLICATIONS, AND SERVICE

The Women's Studies Faculty continued their active contributions to their individual fields. Most of their accomplishments are listed in the reports of their home departments, so special attention is given here to achievements relating to work on gender.

Professor Evelyn Fox Keller (STS) delivered a guest lecture at Cambridge University in their "Gender and Society" series. Associate Professor Evelynn Hammonds (STS) delivered the talk " Feminism, Science, and Diversity: Challenges and Tensions" as a part of the Voices of Public Intellectuals: Feminisms and Science in Civil Society series at the Radcliffe Institute for Advanced Study, which was broadcast on National Public Radio. Professor Hammonds served as Associate Editor of *Signs: Journal of Women in Culture and Society*. She also received a grant of $190K from the Ford Foundation to organize a National Initiative on Minority Women Scientists and Engineers.

Professor Slyomovics (Anthropology) coedited a volume with Suad Joseph: Women and Power in the Middle East (Philadelphia: University of Pennsylvania Press, 2001) that includes a coauthored "Introduction" and article, "Sex, Lies, and Television: Moroccan and Algerian Caricatures of the Gulf War." She also published an interview with Fatna Elbouih and her translation of Fatna Elbouih, Hadith al-Atama, (excerpts appearing in MERIP/Middle East Report, Spring 2001, number 218, pp. 42–43). The interview with Fatna El Bouih and an article on political prisoners in Morocco that can be found online at http://www.merip.org/ by clicking on the magazine issue "Morocco in Transition."

Associate Professsor Diana Henderson (Literature) published the article: "The Disappearing Queen: Looking for Isabel in Henry V" in *Shakespeare and his Contemporaries in Performance* edited by Edward Esche (Aldershot, UK: Ashgate, 2000: 339–355). She delivered the invited lecture: "Gender Gaps: Recasting history or the same old story in Shakespeare in Love?" at University of Pittsburgh, February 23, 2001. Professor Henderson served as Co-Chair of the Women and Culture in Early Modern Europe seminar at The Humanities Center, Harvard University.

Professor Haslanger (Philosophy) won an ACLS fellowship for 2001–2002 for a project entitled: "Embodied Meanings: Social Construction and the Ontology of Race and Gender." She was appointed as Associate Editor of *Hypatia, A Journal of Feminist Philosophy*, 2001–2005. Professor Haslanger presented the following papers: "Social Geographies: Gender Identity, Racial Identity, Mixed Identities," for Greater Philadelphia Philosophy Consortium, November 2000; "You Mixed? Racial Identity without Racial Biology" at the University of Chicago, April 2001, and at Smith College, March 2001. She signed a contract for *Theorizing Feminisms: North American Approaches in Context* (textbook in feminist theory, co-edited with Elizabeth Hackett), forthcoming from Oxford University Press, 2002.

Associate Professor Thomas DeFrantz (Theater Arts) sponsored the visit and presentation by Ananya Chatterjea. In addition to her public presentation, they worked on a performance project called, "Remembering Our Feet: A Dance Collaboration Across Cultures" exploring affinities and differences between classic American dance (tap dance) and classical Indian dance (Kathak). The Theatre Offensive, whose mission is to present the diverse realities of gay and lesbian lives, is presenting a workshop production of *Queer Theory!* by Professor DeFrantz. According to Theater Offensive, *Queer Theory!* offers "burlesque showstoppers, biting satirical comedy and giddy original songs all poking fun at how academics cannibalize our 'queer body' to the point where we've been deconstructed beyond all recognition." Professor DeFrantz was on the plenary keynote panel at SDHS entitled "Dance Studies, Gay and Lesbian Studies, and Queer Theory" including Susan Manning (chair), Valerie Briginshaw, Susan C. Cook, and Ann Daly. He performed his original piece *My Digital Body* at the "Race in Digital Space" Conference in April at MIT.

Associate Professor Justine Cassell (Media Arts and Sciences) received the prestigious Edgerton Award. She served on the Advisory Board for the Institute for Women and Technology at Xerox PARC. She published the chapter: "Gender Differences and HCI" in J. Jacko and A. Sears (eds.), *The Handbook of Human-Computer Interaction* (Mahwah, NJ: Lawrence Erlbaum); and delivered talks at the University of Maryland, Center for Women and Technology (Baltimore, Maryland. October 24, 2000) and at the University of Vermont for the Women's Studies Program (Burlington, VT. February, 2000).

FUTURE PLANS

Professor Henderson will serve as acting director through January 2002. Then Professor Wood will assume the directorship. Both directors are interested in working to widen faculty participation in the program across the Institute, and to strengthen the sense of intellectual community within Women's Studies on campus. We hope more of our subjects can be offered on a regular basis by MIT faculty. The program will continue to pay special attention to the international, comparative study of gender and to the roles of women in science and technology, as areas particularly appropriate to Women's Studies at MIT.

More information about this program can be found online at http://web.mit.edu/womens-studies/www/.

Diana Henderson

DEAN, SLOAN SCHOOL OF MANAGEMENT

Sloan's mission is to be the leading academic source of innovation in management theory and practice. MIT Sloan aspires to develop effective, innovative, and principled leaders who advance the global economy and to conduct rigorous and innovative research that improves management theory and practice. The U.S. and global economies have shifted significantly during this 2000–2001 academic year, providing a rich ground of study for economics and business.

EDUCATIONAL PROGRAMS

Sloan continues its tradition of drawing top students from around the world. In fall 2000, 314 men and women—with a median GMAT score of 710—began their two-year MBA program. MBA applications are up 9 percent over last year, reversing the trend of the last year or two, and GMAT scores are up. In the Ph.D. program, international applications have shown a sharp increase, moving from 65 percent of the pool up to 87 percent. The undergraduate program has had tremendous growth in the past six years. Enrollment tripled from 100 to 300 for the fall 2000. The program is now the second-largest undergraduate department in the Institute, behind Electrical Engineering and Computer Science.

Sloan's newly redesigned MBA core requirements have been well accepted by the students. The program was retooled around the School's educational mission: to develop effective, innovative, and principled leaders.

Following are a few highlights from the past year:

We have had two major program anniversaries this year. The Management of Technology Program began celebration of its 20th anniversary this academic year with a symposium on "Innovation to Implementation... managing in a Complex World" and a dinner at the JFK Library. The Sloan Fellows program for outstanding mid-level managers marks its 70th year. This program existed long before the naming of the Sloan School.

Faculty in the Center for eBusiness at MIT began using "live cases" in their classes this year, to compensate for the rapid change in that field and the lack of formal case studies. In this new format the CEO brings in a current problem and the students work to devise a solution.

This year for the first time LFM and SDM alumni have gathered virtually for post-degree learning through a new on-line seminar series.

The Ph.D. research concentration formerly named Industrial Relations has been renamed the Institute of Work and Employment Research to better fit with today's more complex workplace.

In conjunction with Merrill Lynch, we have developed an exciting new financial engineering executive education program where course participants from the company develop a complex set of tools for designing financial solutions and products for areas ranging from proprietary trading to risk management to corporate financial management, all in an innovative distance learning/e-learning environment.

STUDENT PROGRAMS

Students participate in over 50 active clubs and organizations at Sloan. These range from professional clubs to athletic groups to trip-focused groups. Following are just a few of the highlights:

Annual student-run events were very successful this year. Our MIT Sloan eBusiness awards and the MIT $50K Entrepreneurship Competition provided students with valuable leadership opportunities, with the latter $50K providing good opportunities to develop links with students across campus. This year Management of Technology student Sudhir Borgonha, M.D., was a member of the $50K's winning team, Angstrom Medica. In addition, the group Project Team provided enriching opportunities for students to develop teamwork skills. One of the highlights was a new initiative, Team Day where students took a day away from academics to understand how teams could function better.

Special Seminars in International Management, which include trips, are a big part of many MBA students' experience. This year trips included China; the Middle East; India; Japan and Korea; and Finland, Sweden, and Norway. Students also have opportunities for other study/networking trips, including Tech Treks to New York City, Massachusetts and Silicon Valley where students hear an alumni panel, and get networking, company visits, and interview opportunities.

On their study trips students got to meet with the Honorable Donna Shalala, Brookings Institution guest scholar and former secretary of the US Department of Health and Human Services; Stanley Fisher, first deputy managing director of the International Monetary Fund; Dr. Keijo Tachikawa, president and CEO of NTT DoCoMo, among many others.

Five students received top honors at the 2nd annual Kenan-Flagler Marketing Case Competition where mixed school teams presented marketing recommendations to the Walt Disney Company. Sloan winners, all MBA class of '02, were Craig Westmoreland, Carolyn Corazo, Allison Conrad, David Harelick, and George Karayiannakis.

Sloan Leadership Forum's annual conference featured Warren Bennis, author and Chair of the Leadership Institute at the Marshall School of Business along with a number of CEOs and VPs.

ALUMNI INVOLVEMENT

The number of alumni participating in any of the many activities offered grew significantly this year. Well over 3000 alumni attended club events, alumni weekend, returned to speak to students, attended c-functions (social events), joined the students during international trips, gathered at corporate sites, networked, and much more. With 20% of Sloan's reunion year alumni returning to campus, Sloan once again set records for reunion attendance. To thank them for their work on Sloan's behalf, volunteers from around the world were invited back to campus for the Alumni Leadership Conference where they enjoyed hearing from faculty.

NEW FACULTY AND HONORS

Sloan continued to expand its faculty with several new appointments, and current faculty received a number of honors and awards. Gerhard Schulmeyer, President and CEO of Siemens Corporation, was named to the Sloan faculty as a Professor of Practice, effective July 1, 2000. Other new appointments included Pablo Boczkowski as Assistant Professor of Organizational Studies; M. Diane Burton as Assistant Professor of Management; Roberto Fernandez as Professor of Organizational Studies; Richard Frankel, Peter Joos and Joseph Weber as Assistant Professors of Accounting; Benjamin Grosof as Assistant Professor of Information Technology; Starling Hunter III and Fiona Murray as Assistant Professors of Management of Technology, Innovation and Entrepreneurship; Jun Pan, Anna Pavlova, and Antoinette Schoar as Assistant Professors of Finance; Thomas Roemer as Assistant Professor of Operations Management; and Jesper Sorensen as Associate Professor of Strategic Management.

Faculty honors of note include the following:

Tom Allen received an honorary doctorate degree from Linkoping University in Sweden Saturday in May 2001.

In November 2000, Dan Ariely received the Hillel Einhorn Young Investigator Award from the Society of Judgment and Decision Making.

Arnold I. Barnett was chosen by the Operations Research Society to present the prestigious Blackett Memorial Lecture in London in November 2000.

During the Institute Awards Convocation held in May 2001, Paul Carlile was the recipient of the Graduate Student Council Teaching Award for his course, Organizational Processes.

Robert S. Gibbons accepted an invitation to join the Board of Trustees at the Center for Advanced Study in the Behavioral Sciences at Stanford University.

John Hauser received the 2001 *Charles Coolidge Parlin Award* at the American Marketing Association (AMA) 22nd Annual Marketing Research Conference in Atlanta. The Parlin Award is the oldest and most distinguished award in the marketing research field. It recognizes distinguished academics and practitioners who have demonstrated outstanding leadership and sustained influence on the evolving profession of marketing research.

John Little was chosen as the recipient of the INFORMS Expository Writing Award which is given annually to an author whose publications in operations research and management sciences have set an exemplary standard of exposition.

Andrew Lo was chosen as the IAFE-SunGard Financial Engineer of the Year for 2001. This honor is given each year by the International Association of Financial Engineers to a distinguished academician or practitioner in recognition of outstanding lifetime contributions to the field of financial engineering.

Tom Magnanti received the Irwin Sizer Award for the Most Significant Improvement in MIT Education at the Institute Awards Convocation in May 2001

Wanda Orlikowski, Tom Malone, JoAnne Yates, Peter Weill, and Erik Brynjolfsson have been awarded a $5.2 million NSF Information Technology Research Award for their project, "Social and Economic Implications of Information Technology: What is Really Happening?"

Georgia Perakis was named a recipient of the fifth annual Presidential Early Career Awards for Scientist and Engineers, in a ceremony at the White House. She also received a Faculty Early Career Development Award from the National Science Foundation.

William F. Pounds received the prestigious Director of the Year Award at the Corporate Directors' Annual Corporate Governance Conference.

The Association for Investment Management and Research (AIMR) presented Steve Ross the Nicholas Molodvsky Award in May 2001 for "outstanding contributions of such significance as to change the direction of the profession and to raise it to higher standards of accomplishment."

Edgar H. Schein was the first recipient of the Academy of Management Careers Division's Everett Cherrington Hughes Award for Careers Scholarship. The award was instituted to recognize scholarship which has made a significant contribution to the task of linking careers theory with the broader field of organization studies.

Lester Thurow received an honorary doctoral degree from Tehnion University in Haifa, Israel on June 11, 2001.

RESEARCH CENTERS

Tremendous work continues to come out of Sloan's research centers, many of which are run in partnership with colleagues in other schools at MIT. A few highlights include the following.

The Center for eBusiness@MIT has brought together over 30 faculty to work on 35 research projects, funded by the center's generous sponsors. The center also works with Sloan's eBusiness Track, executive education programs and Ph.D. research seminar.

Entrepreneurship activities are continuing to thrive at Sloan. Forgetting for a moment the stock market, there is still tremendous interest in Sloan's entrepreneurship courses, the track and Sloan's research. MIT has always been about innovation and there's been no slowing of innovation here.

Global e-lab gives students the opportunity to work in-depth with start-up companies around the world. The student teams work intensively here and on-site at the companies to define a serious and pressing company issue such as a need for financing or a product launch. They then develop and present their recommendations to the company CEO during spring break

Work in three research centers: the New Economy Value Research Lab, the International Center for Research on the Management of Technology, and Inventing the Organizations of the 21st century has come to a close in the last year.

INTERNATIONAL INITIATIVES

This year we concluded the fifth successful year of our collaboration with three of China's top universities and we have made a commitment to continue to work together in developing international management education programs. Through this program we have worked jointly with the faculty in China to develop their faculty, curriculum requirements and teaching media for international MBA programs. Now, young Chinese professionals have entered the workplace with a broad grounding in the best international management theory and practice—ready to serve China and the world economy today and in the future. Through this program we all share a much richer understanding of the business underpinnings and current practice of our diverse cultures.

ORGANIZATIONAL CHANGES

Steven Graves, Abraham J. Siegel Professor of Management and co-director of the LFM/SDM programs, was chosen as the Institute's new chair of the faculty.

The MIT Sloan Management Review incorporated MIT into its title and launched a crisp and colorful new design, one fitting its status as a leading academic research publication. Substantial investments were made in both circulation and editorial quality.

NEW CAMPUS DEVELOPMENT

Sloan is now moving toward development of a new set of buildings that will become the heart of activities at the MIT Sloan School of Management. These new buildings will enable us to create a world-class facility for management education and research on the MIT campus. During this academic year we have announced a team of architects who will design and oversee the project. The architecture team is Moore Ruble Yudell Architects & Planners of Santa Monica, CA in association with Sasaki Associates of Watertown, MA. Both firms are noted as respected leaders in planning and design for college and university campuses. The site that will be used will be announced in the fall, after refining Sloan and SHASS's needs and conducting a site analysis.

CAPITAL CAMPAIGN AND FUNDRAISING

Our capital campaign is off to a good start with over $107 million already raised to support Sloan's priorities and projects. With three years remaining in the drive, we are optimistic that despite the unsettled economy we will meet our goals. This year we are fortunate to have received a $5 million endowment fund from John C Head III and his wife Madie Ivy. This $5 million fund is one of the largest private gifts to Sloan and has established the John C Head III deanship.

MISCELLANEOUS

In September 2000, Sloan became one of the first business schools to embrace wireless network access to stimulate innovation. Sloan activated a wireless access network that enables students, faculty, and staff to use their laptops to connect to the MIT wired network and the Internet from anywhere on the Sloan campus. This comes on the heels of Sloan being the first business school to require online applications in 1999, the same year the incoming MBA class built a web site that formed a virtual community before students arrived on campus. With the new wireless access students can communicate instantaneously with project team members, work from a much larger variety of locations and can now access the Internet for up-to-date company news and research.

A number of top corporate and government leaders spoke at Sloan over the last academic year, providing insight to students, faculty, researchers and alumni. Speakers included: Spain's Vice President and Minister for Economics and the Treasury, Rodrigo Rato; Texas Instruments' Chairman and CEO, Thomas J. Engibous; Michael Dell; and Jeff Wilke of Amazon.com.

The 2001 The Lemelson-MIT Student Prize, housed at Sloan, was presented to mechanical engineering doctoral candidate Brian Hubert for his development of the world's first nano-assembly machine, capable of picking up and assembling any kind of material, several thousand atoms at a time.

We have continued to be well rated among industry rankings and use them as one of many forms of feedback. In the Business Week ratings that were released in September 2000, Sloan's MBA program was ranked fourth, moving up an incredible 11 places from the last survey. In January, MIT Sloan was ranked number 6 in the *Financial Times* 2001 rankings of the top 100 MBA programs in North American and Europe. In *U.S. News & World Report's* 2001 edition of Best Graduate Schools MIT Sloan was ranked as number five among MBA programs. As counter point, in April the *Wall Street Journal* released its first business school ratings, entirely based on feedback and data from recruiters. Sloan was ranked 38th out of 50 schools. Other top schools whose graduates are hard to hire because they are in great demand, also did poorly in this survey. While we do not feel this ranking is a proper reflection of the quality of the education we provide or the success of our graduates, we respect their right to choose their own criteria.

2001 PRIORITIES

Our top priority, as always, will be conducting leading research and providing a first-class education for top students around the world. This next year we will begin the celebration of our 50th anniversary, a time for rejoicing and reflection. It will allow us time to highlight what we have accomplished in the past as well as plan for our future and will include a number of events and projects, beginning next spring. The development of our new campus buildings will move into the design phase in Fall 2001, an exciting step for us as we glimpse our future environs. Our capital campaign, currently underway, will help make that vision possible.

More information about the MIT Sloan School of Management and its programs can be found on our web site at http://mitsloan.mit.edu/.

Richard Schmalensee

EDUCATION

MBA PROGRAM

The MBA Program at the MIT Sloan School of Management includes three areas—Admissions, Student Affairs, and the Career Development Office. The MBA Program has had a busy and productive year. We reorganized into a more efficient structure, hired new people, and continued to build a new organization, revamped and enhanced many of our offerings, and created new programs. We've also made strides in terms of student satisfaction and been recognized with outside rankings (fourth in *Business Week*, fifth in *US News & World Report*, sixth in *Financial Times*). The program's continued high rankings are recognition of our student selectivity, high graduation rate, employment success, and academic reputation.

In keeping with the MIT Sloan School mission statement, we are dedicated to developing effective, innovative, and principled leaders who advance the global economy. We will work toward aligning our offerings with what students need to be successful in their time at Sloan and in their lives after Sloan. We also will refine our marketing message content and delivery, create new offerings and ways of working together to create a more differentiated, successful program.

DOCTORAL PROGRAM

Sloan's Doctoral Program aims to provide institutions in the United States and abroad with outstanding management faculty and researchers. On the output side, we graduated 13 people this past academic year with job success and placements being quite good in all of our management fields. Recent graduates have found positions at Harvard, Columbia, Carnegie Mellon, Cornell, New York University, Seikei University, and the London Business School . Although some graduates succumbed to the blandishments of industry, most remain committed to academic careers.

On the input side, we experienced another record-breaking year, due in part to the ease of access to our web page (http://mitsloan.mit.edu/) and the application form availability via this method. We received 522 applications from

61 countries, 31 percent from China. We made 29 offers and got 19 acceptances (66 percent yield) and believe that the upsurge in acceptances is directly correlated to the major improvement in the financial aid offers, bringing us up to the mid-range of offers tendered by comparable schools. Total enrollment now stands at 90, with 60 international and 30 U.S., and a total of 27 women. While the number of under-represented minority students has dropped to two active students, we continue initiatives begun four years ago to increase our diversity, including participating in the KPMG Peat Marwick Ph.D. Project (an annual recruitment event). We also continue to explore other means to increase the participation of minority students in Ph.D. studies here.

Sharon Cayley

MBA STUDENT AFFAIRS OFFICE

The MBA Student Affairs Office staff had an eventful and productive year. Overall full-time MBA student enrollment at Sloan, including Leaders for Manufacturing, is 732 (634 MBAs and 98 LFMs). The final phase of the Core 2000 redesign and rollout included the addition of an introductory marketing elective in the Fall 2000 Core, which complements the introductory finance elective, put into place in 1999. The finance and marketing electives were popular options for the first-year MBAs; 94 percent of the overall MBA'02 class (including first-year Leaders for Manufacturing students) chose to take an elective in their Core term, with 64 percent of this group enrolling in marketing and 36 percent taking finance.

After students complete their required fall core requirements, they then choose a specific Management Track or Self-Managed Track, all of which require the completion of a sequence of extended "Spring Core" electives common to all the tracks in addition to each track's specialized electives. The Core 2000 initiative also encompassed changes in the Spring Core; the required sequence format for the 2001 Spring Core was expanded from one "4-of-6" series to two "3-of-5" sets of subjects, all of which were successfully delivered. The MBA Fall and Spring Core curricula will continue to be monitored and adjusted as needed on an ongoing basis by the School's Master's Program Committee.

The MBA Program currently has a roster of seven Management Track offerings—Financial Engineering, Financial Management, Strategic Management and Consulting, Information Technology and Business Transformation, Manufacturing and Operations, eBusiness, and New Product and Venture Development. More than two-thirds of graduating MBA students completed a Management Track in Academic Year 2000–2001, with an especially strong enrollment demonstrated by students drawn to the New Product and Venture Development Track's emphasis on entrepreneurship and new product marketing. Students who did not join one of the seven tracks noted above opted for the Self-Managed Track, which provides them with maximum flexibility of course selection and the ability to customize their program following completion of the Fall Core.

The Minority Business Club met regularly during the academic year to discuss minority student issues. The MBA Program again subsidized the membership of minority students in the National Black MBA and National Hispanic MBA associations, allowing students to attend national conferences. Both groups developed résumé books and used them at career fairs for these events.

MBA students, faculty, and staff participated in five school-sponsored international trips last year. The international trips continued to be an important part of the MBA Program student experience; students, the MBA Student Affairs Office, and International Management faculty worked collaboratively to organize the trips. An academic seminar that examines the relevant management, social, and cultural issues of the countries precedes the trip. The trip destinations last year were Japan and Korea; Jordan, Turkey, and Syria; Finland, Norway, and Sweden; India and China. More than 200 MBA students participated.

MBA CAREER DEVELOPMENT OFFICE

The 2000–2001 Academic Year was a successful one for Sloan students in the MBA job marketplace and for the Career Development Office (CDO) staff assisting them with this process. The CDO offered over 65 seminars on 31 different topics during 2000–2001. Subjects ranged from an overview of effective career management to self-assessment, resume development, networking, conducting a proactive job search, managing relationships with employers, interviewing, negotiating, evaluating offers and making final career decisions. Seven new seminar topics were introduced to address special search issues: behavioral interviewing, Interviewing 101, interviewing for consulting, banking, investment management, high technology careers, and Career Options Day.

From October through June, CDO staff held over 650 individual counseling appointments, in addition to answering regular questions on a drop-in basis. Support for more than 200 alumni seeking new career opportunities were also provided during this period of time.

The MBA Career Development Office coordinated the logistics for 120 corporate presentations and over 340 interviewing companies. In addition, the CDO successfully attracted 69 new firms to recruit our students during the 2000–2001 academic year; these firms participated in traditional recruiting processes as well as through three spring semester career fairs.

At graduation, 90 percent of the Class of 2001 reported receiving a job offer. The median starting salary for accepted positions increased to $95,000 from $90,000 in 2000. Forty-five percent of the Class of 2001 chose to join a consulting firm. This is an increase of 15 percent from 2000.

ADMISSIONS OFFICE

This has been another highly successful year for Sloan Admissions. The new MBA Class of 2003 is made up of 378 students, including 48 students for the Leaders for Manufacturing Program and joint Sloan/Engineering candidates. Continuing the trend of the past several years, the class is an experienced one, having an average of five years of employment before matriculating. The average age is 28 years. Average GMAT score has risen to 710 (median is 710).

Sloan continues to be a diverse population on all dimensions. The incoming class is 35 percent international (45 countries are represented), 30 percent women, and 5 percent underrepresented minority students. Sixteen members of the first-year MBA class matriculating in September 2001 are from underrepresented minority groups. The Class of 2003 includes 10 African-Americans and 6 Hispanic-Americans; they joined 27 second-year minority students.

In addition, students have come from all over the United States with backgrounds in engineering, mathematics, economics, political science, history, languages, international studies, social science, business, publishing, law, computer hardware and software, communications and transportation. Many are already entrepreneurs who have founded their own businesses.

The total number of applications was 2964. The number of applications held very steady this year and in the second round of applications, the number and percent of applications increased. We continue to see a diversification of our applicants to include doctors, lawyers, architects and other professionals who find themselves in need of sophisticated management skills to complement their professional expertise. This year's applications came from all 6 continents.

The virtual community developed by the incoming students two years ago has grown into a partnership with the Admissions office whereby students connect with each other before arriving on campus and the Admissions and MBA program management are also communicating with students in an official capacity.

A new MBA admissions web site will be launched in September 2001 in an effort to maximize Sloan's presence on the internet and reflect its reputation as an innovator and leader in technology. Since 100 percent of Sloan's applicants apply on-line, the site will be updated to provide succinct information with the highest standards of usability.

Sloan will also be in the road this year. Currently, the Admissions office has 17 international events planned; including MBA Fairs, symposium and Sloan Evening Presentations. To increase the pool of domestic applicants, we are sponsoring and/or participating in 28 events planned around United States including 15 Sloan Evening Presentations, 5 MBA Forums, 4 "Top 10" school events, 2 professional associations fairs and 2 symposium. The enthusiastic participation of alumni and student volunteers in these events demonstrates their continued commitment to the Sloan family and their satisfaction with its programs.

LEADERS FOR MANUFACTURING

The Leaders for Manufacturing (LFM) Program is a partnership between MIT and over 25 global manufacturing firms to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. This partnership is motivated by our shared belief that excellence in manufacturing is critical to meeting the economic and social needs of individuals, firms, and society, and that the health of companies operating in global markets is essential to society's well-being.

Now, in its 13th year of operation, LFM is a partnership between the School of Engineering, the Sloan School of Management and leading manufacturers. Launched in 1988 with significant industry funding, the program emphasizes collaboration and knowledge sharing with its partner companies across the entire spectrum of "Big-M" manufacturing enterprise issues. LFM supports students both as fellows in the program (with fully-paid tuition). The largest component of the educational efforts is the Fellows Program, a 24-month dual masters degree (S.M. in engineering and MBA or S.M. in management) experience involving a single integrative research project carried out on site in partner firms.

Academic Programs

Forty-eight students in the class of 2001 completed the Fellows program and approximately 80 percent have taken positions in manufacturing firms. Each of the 48 graduates completed an internship at a partner company during the summer and fall of 2000. Internships are focused projects of concerns to the partners, accomplished by interns with company support and MIT faculty guidance. Representative projects this past year included modeling design rework in a product development process, integration of the design and manufacture of high-precision cast components, evaluating wastewater treatment technologies, and addressing the complexity of multimedia wireless computing solutions, among others.

Another 49 students (class of 2002) completed their first year of on-campus studies and are starting their six-month internships. Forty-eight new students (class of 2003) were admitted and have begun an intensive summer session. The class of 2003 has an average of 4.8 years of work experience.

Don Rosenfield continues to serve as the Director of LFM Fellows. Co-directors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger. Steve Eppinger, GM LFM Professor of Management at the Sloan School of Management, assumed the LFM-SDM co-director's position on July 1, 2001 when Steve Graves, who has been an LFM co-director for 10 years, was elected Chair of the Faculty. Both began their new position effective July 1, 2001. Steve Eppinger is no stranger to LFM-SDM. His course, Product Design and Development, is a favorite of students in both programs, and he frequently supervises LFM and SDM students for internship and theses projects.

Research and Knowledge Transfer Program
As part of LFM and SDM's commitment to lifelong learning, a new initiative was introduced to encourage LFM and SDM alumni to stay connected with MIT by sharing relevant information. Paul Gallagher, research associate for LFM and SDM, established monthly webcasts presented by various LFM and SDM alumni. The content of each webcast, also called e-seminars, provides valuable information on the latest trends, cutting-edge developments and innovative strategies, all of which pertain to manufacturing and/or systems design. The presentations are given in real time, via the Internet and telephone, which allowed participants to follow along visually and audibly as well as ask questions.

Presenters have included Steve Graves discussing his research on supply chain issues, Don Rosenfield on manufacturing strategy, and Sara Beckman, from the HAAS School of Business at UC Berkley, talking about vertical vs. virtual integration. Due to the positive feedback, the webcasts will continue into the next academic semesters.

Outreach
LFM continues its leadership role in the National Coalition of Manufacturing Leadership (NCML), a partnership of 15 universities with joint management and engineering manufacturing programs. In conjunction with the NCML, MIT, Univeristy of Michigan, and Penn State University once again sponsored a recruiting forum the National Manufacturing Recruiting Forum (NMRF) hosted this past year by Penn State University. More than 118 students and 50 companies participated in last year's event, in which LFM makes a significant contribution to the NMRF by providing a robust, web-based interview scheduling system that increases interview scheduling efficiency. The NCML meets twice a year to share curriculum, research, and program best practices.

Placement
LFM students, sponsored and non-sponsored, continue to be highly sought once they have completed the program. Partner companies as well as other organizations take a special interest in LFM students as proven by their commitment to speak to the class on various issues during the Pro Seminar session. About 80 percent of each class accept positions within the manufacturing industry while the percentage of students aceepting positions within partner companies has remained at about 50 percent. Within the past two years, however, LFM has experienced a slight increase in the number of graduates who have accepted positions in consulting. Ten percent to 15 percent of students have chosen this field.

More information about LFM can be found online at http://lfm.mit.edu/.

William C. Hanson

EXECUTIVE EDUCATION
Sloan's office of Executive Education has continued its efforts to provide superior programs to key partner companies and alumni of executive education, drawing on Sloan's research depth and expertise to help managers and executives solve important business problems. The offerings of Executive Education increased during the year responding to the demand for open-enrollment courses and for customized programs. Both the Sloan Fellows and Management of Technology programs, flagship programs for executive education at Sloan, successfully recruited full classes for 2000–2001, indicating continuing strong demand for these mid-career management degrees. Five executive short courses of five days each were successfully presented in May and June. A two-week course on Latin American business was run in October and will be offered again in response to enthusiastic demand. And the portfolio of open enrollment two-day courses has increased dramatically over the year. Responding to market demand for more customized programs, Sloan increased its offerings of executive education programs for individual companies such as McKinsey, Siemens, and TRW. Topics of particular interest are strategic management of technology, the impact of emerging technologies on current business models, and the challenges of organization transformation. The Office of Executive Education is leveraging new learning technologies in both its custom and on-campus programs. A successful, new program this year was developed for Merrill Lynch, a MIT partnership company. Using distance learning technology, Professor Andrew Lo's Advanced Investments course was offered to Merrill Lynch traders around the world. Being at the forefront of new learning technologies allows Sloan's Office of Executive Education to meet the needs of its corporate partners for cutting-edge knowledge on a global basis. More information on executive education at Sloan can be found online at http://mitsloan.mit.edu/execed/.

Marie T. Eiter

SYSTEM DESIGN AND MANAGEMENT

The mission of the System Design and Management Program is to educate future technical leaders in architecting, engineering, and designing complex products and systems, preparing them for careers as the technically grounded senior managers of their enterprises. SDM intends to set the standards for delivering career-compatible professional education using advanced information and communication technologies. SDM was one of MIT's early entries into the field of distance education and remains the only degree-granting program at MIT that can be earned primarily from a remote location.

The SDM program is a joint offering of the School of Engineering and the Sloan School of Management, leading to a Master of Science degree in engineering and management. Targeted for professional engineers with three or more years of experience, the program centers on a 13-course curriculum in systems, engineering, and management, including a project-based thesis. It offers three curricular options: a 13-month in-residence format; a 24-month distance education for company-sponsored students, requiring one academic semester in-residence at MIT; and a 24-month on-campus program for self-supporting students who can obtain a research assistantship in one of MIT's labs or centers. The program was conceived as an alternative to the MBA for professional engineers, allowing working professionals to pursue a degree without interrupting their careers and relocating themselves and their families. Denny Mahoney, Director of SDM Fellows, completed his second year in that position, providing a much-needed stability to program leadership. Co-directors for the program include Paul Lagace, Bill Hanson, and Steve Eppinger. As of July 1, 2001, Steve Eppinger, GM LFM Professor of Management at the Sloan School of Management, will assume the LFM-SDM co-director's position when Steve Graves will be appointed Chair of the Faculty.

SDM Student Statistics

In January 2001, SDM admitted its fifth class, enrolling 37 students. In all, 11 organizations sponsored students in the incoming class, including LFM-SDM partner companies: UTC (3), Ford Motor Company (10), NASA (10), Eastman Kodak (1).

In June 2001, SDM graduated its third full class. Forty of the 49 graduates attended the commencement ceremony to receive their degrees—a testament to the cohesiveness of this distance education group. The graduating class includes 11 employees from Ford, 10 from UTC, eight from Xerox, one from Eastman Kodak, as well as employees from Polaroid, Visteon, GM Delphi, GTE, Honeywell, Intel, the U.S. Navy, and Gemcor. SDM continues to draw from a wide range of companies for its students. This past year, ArvinMeritor sponsored three students in the January 2001 class and has expressed interest in participating in the LFM-SDM partnership. Xerox, a long-time supporter of SDM, did not sponsor any employees this year because of difficult economic times for the corporation. United Technologies Corporation, which usually enrolls a significant number of employees into each SDM cohort, only sponsored three employees in SDM who were all from Pratt & Whitney, one of UTC's divisions. Several other business units within UTC, most notably Sikorsky and Otis Elevator, which normally sponsors students in SDM, did not do so last year because of internal reorganization. UTC, however, expects to increase its overall participation in SDM in the next intake as a result of a new educational partnership.

Table 1. SDM Student Statistics

	1997	1998	1999	2000	2001
Admitted	35	58	47	50	37
On-Campus	8	16	6	14	8
Self-Supported	3	1	2	5	2
Research Assistant	3	12	2	4	3
Distance Education	27	42	41	36	29
Company-Sponsored	29	45	43	41	32

MIT-UTC System Integration Project

This past year, LFM-SDM and UTC embarked on a new educational venture. UTC has identified 11 core capabilities that the corporation believes must be strengthened across all the business units for UTC to remain competitive in the next century. For each capability, UTC will partner with a university that can deliver the highest quality education to its workforce in each of these areas. UTC proposed that LFM-SDM serve as its partner for one of these competencies—Systems Engineering. UTC believes that much of the current SDM curriculum addresses many of the required capabilities needed for systems engineering that they have identified as important across the UTC business units.

The project team has segmented the educational process into four target populations—a group of experts enrolled in the SDM program, a second group of experts enrolled in UTC-MIT's Systems Integration Certificate Program, the managers/facilitators of the experts, and implementers/doers. A holistic approach recognizes that each target population is part of a larger whole and tries to identify the critical points and people in a process where new knowledge must be applied.

The project team identified the certificate program as its priority, and a pilot class of 12 students will begin the new certificate program starting Fall 2001. It is expected that this project will not only provide the Institute with an important experiment in lifelong learning, but will also solidify a higher level of enrollment by UTC employees in the regular SDM program.

Distance Education Delivery
As MIT's premier degree program offered at a distance, SDM has recognized its leadership role at the Institute regarding the practice of distance education and is in a process of evaluating its delivery with the goal of increasing the quality of the remote-learning experience while reducing costs.
Specific distance education accomplishments include:

- Delivering the full range of SDM course offerings to all of its students;
- The adaptation of other courses for the distance education medium of multipoint videoconferencing to as many as 15 simultaneous company sites;
- Jan Klein's funding by NASA and Ford Motor Company on a proposal to apply her research on Virtual Teams to improving the SDM distance learning experience. She conducted a survey and will introduce and measure specific change elements into the program;
- SDM's efforts to experiment with new distance formats. For example, when SDM students could not get into Rebecca Henderson's Technology Strategy course because of over-enrollment, SDM program administrators created a course format in which SDM distance students received the core of Henderson's teaching via videotape. This included videoconferenced recitations and a half-day workshop on campus facilitated by Henderson herself. A similar approach was taken with Steve Eppinger's Product Design and Development course in the spring;
- Another experiment with Systems Dynamics, in which Jim Hines, a senior lecturer in the Sloan School, is offering a web-based, asynchronous course to SDM students both on and off campus, during summer 2001.

SDM will continue to explore effective ways of making course materials available to distance students.

More information about SDM can be found online at http://sdm.mit.edu/.

William C. Hanson

MANAGEMENT OF TECHNOLOGY PROGRAM
The MIT Management of Technology Program (MOT), the first joint program between the Sloan School and the School of Engineering, was established in 1981 to develop leaders who can create the linkages between their organizations' underlying technology and overall strategy. This 12-month intensive program provides executive development for strong technical leaders who are taking on senior leadership positions in their firms, and has also attracted an increasing number of participants who are involved in technology-based entrepreneurial opportunities.

The MOT Class of 2001 included 57 participants from 23 countries, the largest and most internationally diverse class in the 20-year history of the program. They averaged 11 years of work experience, representing a wide variety of industries and functional expertise. More than half of the class had advanced degrees prior to joining the MOT Program, most in technical disciplines.

This past year, domestic field trips provided the MOT class an opportunity to visit leading high technology firms on both coasts of the United States. In November, the annual trip to New York included visits to telecommunications, financial services, media, electronic commerce and technical consulting organizations. In January, the group spent a great week in Silicon Valley, visiting a wide array of large and small technology-based firms, venture capitalists and intellectual property consultants. While large firms such as Cisco, Sun Microsystems, Hewlett-Packard, Agilent, and Oracle provided great insights into how technological innovation is implemented, much was also gleaned from visits to smaller firms, particularly those involved in wireless applications and e-commerce services.

In March 2001, the MOTs set out for the England, Ireland, and Spain on their annual International Field Trip. Visits to large organizations such as BP Amoco, British Telecom, and National Grid were interspersed with smaller entrepreneurial firms in Dublin and Barcelona. Visits to Cambridge University and the new MIT Media Lab Europe in Dublin took advantage of MIT ties in England and Ireland. Colleagues at University College Dublin and IESE in Barcelona were also instrumental in setting up excellent company visits in those countries. Waterford Crystal, which offered hands-on exploration of both old and new manufacturing technologies, was a highlight for the whole group.

In April 2001, over 525 people attended a conference jointly sponsored by ILP, ICRMOT and the Management of Technology Program, marking 10 years of sponsored research in the field of managing technology and innovation. Many MOT students participated in presentations and poster sessions surrounding this excellent conference.

In June 2001 in conjunction with the graduation of its 20th class, the MOT Program sponsored a series of events celebrating the 20-year history of the Program. A full-day symposium entitled "Innovation to Implementation....Managing in a Complex World" and a gala dinner at the JFK Library on Boston Harbor were highlights of the three-day celebration. Other satellite celebrations are being organized over the next year in other locations around the world.

More information about the MOT Program can be found online at http://mitsloan.mit.edu/mot/.

David A. Weber

SLOAN FELLOWS

The Sloan Fellows program is the oldest degree granting executive education program in the world. Begun in 1931 with the backing of several industrialists, it was designed as an innovative 12-month graduate program covering the fundamentals of management and managerial decision-making. Now in its 70th year, the program has evolved over the years to keep abreast of a changing world and has remained the leading choice among the world's top corporations to prepare today's managers to be tomorrow's leaders. The individuals designated as Sloan Fellows are fully sponsored by their organizations during their year at MIT.

The program continues to make a significant contribution toward achieving the Sloan School's strategic objectives: to develop effective, innovative and principled leaders who advance the global economy and to conduct rigorous and innovative research that improves management theory and practice.
In support of the first objective, the program attracts and educates individuals from corporations that are industry leaders from around the world. The class of 2001 came from 19 U.S. and 38 foreign organizations, many of which have long associations with MIT. They represented 20 different nations spanning six continents and numerous industries, including automotive, energy, telecommunications, and financial services. This profile provided an excellent opportunity for cross-cultural and cross-industry exchange, a hallmark of the Sloan Fellows Program. The class formed a diverse, mutual-learning community from which individuals took away not only the analytical tools necessary to perform, but also the intellectual confidence to help them to make the right decisions in the complex environments they face. Addressing the second objective, through an active alumni network, strong partnerships with sponsoring organizations and the Sloan Fellows' thesis work, Sloan faculty have enjoyed many opportunities to conduct research in which to improve management theory and practice.

Active participation by Sloan Fellow Alumni in program and MIT events continued. The Sloan Fellows class of 1960 held their annual reunion in Boston and invited the class of 2001 to a reception that included a talk by Lester Thurow. The Seminar in Leadership series and the annual Sloan Fellow Field Trips to New York, Washington, and an International Trip to Mexico and Brazil all provided opportunities for alumni to take an active role as speakers and hosts.

A major initiative begun during the year was a comprehensive review of the Sloan Fellows Program. The primary objective of the review, which will continue through 2001 and include discussions with key stakeholders of the program, is to examine the position of the Sloan Fellows program in the executive education marketplace and within Sloan, the curriculum offered, and the delivery of the program. The ultimate goal is to create a program that is a world leader in degreed executive education and meets the management development needs of strategically important sponsors and the professional and personal needs of the Sloan Fellows themselves.

More information about the Sloan Fellows Program can be found at http://mitsloan.mit.edu/sf/.

Stephen Sacca

SLOAN VISITING FELLOWS PROGRAM

The MIT Sloan Visiting Fellows Program provides the opportunity to pursue full-time, non-degree studies tailored to individual goals and interests. Each Visiting Fellow's program of study, usually for one or two semesters, is designed in consultation with a faculty adviser to meet individual professional needs and interests.

Sloan Visiting Fellows is a small program. Participants usually have an existing relationship with the school through their company, their school or a member of the Sloan faculty. Enrollment per semester averages around twelve. Thirteen participants were enrolled in fall 2000 and eight in spring 2001. The 2000–2001 academic year included both self-sponsored and company sponsored participants as well as visiting students from the Norwegian University of Sciences and Technology and also the Digital Institute of Technology in Munich. In addition, graduates of the Management of Technology (MOT) Program continue regular participation in the Visiting Fellows Program as a second semester or year of sponsored study.

Sponsors of participants included NEC Corporation, Site Design Co., Ltd., Fuji Xerox, Samsung Life Insurance, Norwegian University of Sciences and Technology, and the Digital Institute of Technology in Munich.

More information on the Sloan Visiting Fellows Program can be found online at http://mitsloan.mit.edu/rf/.

Jennifer Mapes

UNDERGRADUATE PROGRAM IN MANAGEMENT SCIENCE

The Sloan Undergraduate Program was ranked second this year, tied with the University of Michigan, for the Best Undergraduate Business Program in the country by the U.S. News & World Report.

In addition, we are now the second largest undergraduate major at MIT—second only to Electrical Engineering and Computer Science. With 109 freshman recently declaring Management Science as their first major we now have over 300 students in our program. Enrollment has tripled since the 1993–1994 academic year. We also continue to see large numbers of undergraduates from other MIT degree programs enrolling in our management subjects.

The Undergraduate Program Office has gone through many changes this year. Last fall the office moved from Building E52 to E40. Ms. Etaine Smith left the program in early December, and Ms. Maggie Devine-Sullivan joined us as the new Assistant Director of the Undergraduate Program in late January.

Eighty-nine S.B. degrees in Management Science were awarded last year (one in September, 15 in February, and 73 in June). Thirty-four of these students chose concentrations (these used to be called "options") in finance, 32 selected information technologies, 17 chose marketing science (previously named "marketing research"), and two elected operations research. In addition, four seniors each completed two concentrations: two with finance and information technologies, one with finance and marketing, and one with marketing and information technologies. Finance and Information Technology continue to be our most popular concentrations.

Sixteen of our students received simultaneous degrees in other MIT departments: Three received S.B. degrees in Electrical Engineering and Computer Science, two received S.B. degrees in Economics, two in Chemical Engineering, and one each in Biology, Brain and Cognitive Sciences, Mathematics, Philosophy and Linguistics, Physics, Anthropology, and Music. Two students received M.Eng. degrees in Electrical Engineering and Computer Science.

One student received three additional S.B. degrees: in Electrical Engineering and Computer Science, in Mathematics, and in Economics. Three students received two additional degrees: one in Physics and in Mathematics, one in Electrical Engineering and Computer Science and in Anthropology, and one received both S.B. and M.Eng. degrees in Electrical Engineering and Computer Science.

Approximately 25 percent of our seniors graduated with minors in other MIT disciplines. More than half of these minors were in economics. Other minors were in architecture, biology, comparative media studies, music, physics, and political science.

SLOAN UNDERGRADUATE ADVISING AND COMMITTEE ASSIGNMENTS

Our increasing number of majors has increased the need for more undergraduate faculty advisors. Last spring we began the process of evaluating the undergraduate advising program at Sloan by individually interviewing our 26 undergraduate advisors. We plan to implement opportunities for increased social interaction and increased program office support for advisors (and their advisees) over the next year.

Faculty serving as undergraduate advisors were Professors Thomas Allen, Daniel Ariely, Dimitris J. Bertsimas, Paul Carlile, John Carroll, John de Figueiredo, Chrysanthos Dellarocas, Stephen Graves, Denis Gromb, Leigh Hafrey, Neal Hartman, Starling Hunter III, S. P. Kothari, John Little, Fiona Murray, Stewart Myers, J.D. Nyhart, James Orlin, Edward Steinfeld, Scott Stern, Yashan Wang, and Roy Welsch along with Sloan Administrators Dr. Jeffrey Meldman, Director of the Undergraduate Programs; Etaine Smith (fall term) and Maggie Devine-Sullivan (spring term), Assistant Director of the Undergraduate Programs; Stephanie Karkut, Program Coordinator; and Debbie Shoap, Director, Sloan Educational Services.

Dr. Meldman served as Chair of the Undergraduate Advisors Committee. The Undergraduate and Interdepartmental Policy Committee was chaired by Professor John Little and included Professors T. Allen, J. Carroll, S. Eppinger, S. Graves, D. Gromb, together with Dr. Meldman, Ms. D. Shoap, Ms. E. Smith, and Ms. M. Devine-Sullivan. Professors Gabriel Bitran and Lawrence Wein served as ex-officio members.

In addition, 35 members of the Sloan faculty supervised Undergraduate Research Opportunities Projects (UROPs) with undergraduates from all MIT departments.

Jeff Meldman, Maggie Devine-Sullivan

RESEARCH CENTERS AND GROUPS

CENTER FOR COORDINATION SCIENCE

The MIT Center for Coordination Science conducts multidisciplinary research to help understand how information technology can provide new ways of organizing human activity and help people work together better. Primary funding comes from a variety of government sources, including DARPA and NSF. The center also has corporate sponsorship from Fuji Xerox, Intel, and British Telecom.

The past year has brought significant progress on the two major projects in center continued from previous years:

- The Process Handbook research area completed the first phase of a collaborative project focused on "supply chain visualization." This project is integrating the process knowledge management functionality of the Process Handbook with tangible user interfaces (from the MIT Media Lab) and process simulation tools (from the MIT Systems Dynamics Group). The first integrated prototype was demonstrated at the end of the year, and a significantly enhanced prototype is expected by the end of next year.
- The Adaptive Systems and Evolutionary Software research area made significant progress in the area of exception handling and norms for multi-agent systems.

In addition, a major new project was added in the past year. This project on the "Social and Economic Implications of Information Technology" is a five-year $5M project, funded by NSF, and performed jointly with CISR and CeB. A primary CCS component of the project is the development of a taxonomy of six basic business models for all companies in the economy and the classification of dozens of companies using this framework.

More information about this center can be found online at http://ccs.mit.edu/.

Thomas W. Malone

CENTER FOR eBUSINESS@MIT

The Center for eBusiness@MIT, created by the Sloan School of Management, has taken as its mission *"to be the leading academic source of innovation in management theory and practice for eBusiness."* The Center engages in research, education, and interaction with industry on all aspects of eBusiness.

In its first year and a half of existence, the center has been fortunate to have tremendous enthusiasm and support from industry, faculty, and students. This has enabled the center to make some substantial accomplishments, including:

- Commissioning 42 research projects involving 50 MIT faculty and researchers, supported by $5.4 million in industry sponsor funding in FY2001 alone;
- Supporting the development of eight new eBusiness courses and an eBusiness Track in the Sloan MBA Program;
- Offering a popular two-day executive education course on eBusiness Strategy three times per year through the Sloan Executive Education Office;
- Engaging the financial support and active participation of 40 corporate sponsors;
- Producing an active sponsor interaction program which includes a large two-day Annual Conference, five other sponsor events, two student recruiting events, web-casting a weekly series of research lunchtime seminars, the annual eBusiness Awards, and hosting many individual company visits to MIT; and
- Establishing a first-class web site for sponsors, faculty, students, and the public, featuring the educational and research projects of our faculty and students.

As we enter FY2002, we are heartened by the fact that most of our sponsors report an expanded commitment to eBusiness practices, technology, and strategies in their operations. The center plans to continue and expand the activities listed above. We plan to grow by adding more sponsors and research projects, by giving our faculty and students more visibility in the business and academic worlds, and by strengthening collaboration with other parts of MIT including the Media Lab, the Engineering and Science Schools, and several other research centers at MIT.

The center has very recently reached nearly full staffing for its activities, which will enable us to further improve our sponsor and faculty support. The center has also relocated to larger office space in NE20, which it shares with two other Sloan research centers. By the end of FY2002 our goal is to have 50 sponsors, contributing at the annualized rate of $6.5 million. Our FY2002 budget shows a modest surplus as a contingency fund from the total revenue forecast of $6.3 million. While the center has been little affected by the recent collapse of Internet startup enterprises, our FY2002 plans and financing could be substantially affected by a prolonged downturn in the U.S. and world economies. Fortunately, we are well positioned with banked funds from FY2000 and 2001. While we have projects planned for these funds, we intend to move forward with them cautiously, as we carefully watch the financial fortunes of our corporate sponsors who provide our funding.

More information on the Center for eBusiness@MIT can be found online at http://ebusiness.mit.edu/.

Peter J. Metz

CENTER FOR ENERGY AND ENVIRONMENTAL POLICY RESEARCH

The Center for Energy and Environmental Policy Research (CEEPR) has been the locus of research at MIT on energy economics since the mid-1970s and on environmental economics since the late 1980s. This research draws on resources from the Sloan School, the Department of Economics and the Energy Laboratory, and it receives financial support from corporations and government agencies. In conjunction with MIT's Center for Global Change Science, CEEPR co-sponsors the Joint Program on the Science and Policy of Global Change, which conducts interdisciplinary research to inform global climate policy.

The most notable publication event during the year was the appearance of *Markets for Clean Air: the U.S. Acid Rain Program*, co-authored by Denny Ellerman, Paul Joskow, Dick Schmalensee, Juan Pablo Montero, and Elizabeth Bailey. This book presents CEEPR's research on SO_2 emissions trading during the first three years of the program, and it is the definitive source of information and analysis concerning the U.S. experience in using tradable permits to achieve environmental goals.

In addition, six working papers and three article reprints, reporting CEEPR-sponsored research, were published, distributed, and posted on the CEEPR website. In November 2000 and May 2001, CEEPR convened its usual

Energy and Environmental Policy Workshop in Cambridge to present research results to corporate and government sponsors and other interested parties.

During the year, the director and executive director of CEEPR were invited to make numerous lectures and other presentations of CEEPR's research principally concerning electric utility restructuring and emissions trading. CEEPR's director, Paul Joskow, was asked repeatedly for advice and comment on the electricity market problems in California, including testimony before the U.S. Senate in June 2001. In April 2001, CEEPR's executive director, Denny Ellerman, was honored by the International Association for Energy Economics as the recipient of its award for Outstanding Contributions to the Profession.

In the 2000–2001 academic year, CEEPR sponsored research on the topics of SO_2 emissions trading, new electricity markets, and energy futures, forwards and arbitrage. In addition to contributions from sixteen corporate sponsors totaling $600,000, CEEPR received two multi-year funding awards during the year: a $300,000 grant from the Environmental Protection Agency to continue its research on the SO_2 emissions trading program for another two years and a three-year grant for $375,000 from the Cambridge-MIT Institute for research on electricity restructuring in conjunction with Cambridge University in the UK. During the 2001–2002 academic year, CEEPR will continue to focus its research on electric utility restructuring and emissions trading.

For more information, please refer to http://web.mit.edu/ceepr/www/.

A. Denny Ellerman

INSTITUTE FOR WORK AND EMPLOYMENT RESEARCH

In FY2000, the Institute For Work And Employment Research's (IWER) multi year project, Reconstructing America's Labor Market Institutions, funded by the Ford and Rockefeller Foundations, completed a manuscript based on the work of the Task Force. The book will be published by MIT Press in November 2001 and is entitled Working in America: A Blueprint for the New Labor Market. A meeting of the Task Force was held on October 13, 2000 to review the draft of the manuscript and a final newsletter detailing the findings of the Task Force was produced in April 2001.

IWER's Sloan Work-Family Policy Network also had a productive year. Network participants met over the course of the year to draft a report. The report will be released on September 14, 2001.

IWER has three new projects beginning July 2001. A portion of the spring of 2001 was devoted to putting proposals together for these projects.

The aim of The MIT Workplace Center is to build—in theory and in practice—a mutually supportive relationship between the performance of firms and the well being of employees, their families, and communities. Focusing on a regional economy, we bring together groups concerned with work-family issues to elicit their ideas and promote coordinated problem-solving. We collaborate with interested firms to design work systems and employment practices that improve the quality of work and family life. Using this experience, we work to create models of work-family integration that will be useful in other areas of the country.

The Kaiser Permanente Union Management Partnership Study will analyze and track over time the development, evolution, and impact of the Kaiser Permante Labor Management Partnership on the objectives the parties to the partnership have established for it.

A two-year grant from the Annie E. Casey Foundation will support research on the interaction of economic development and labor market policies with community organizing strategies. The focus will be the activities of the Industrial Areas Foundation in the Southwest.

MIT Sloan Management Review

MIT Sloan Management Review (SMR) is a peer-reviewed journal that disseminates research from the top business schools, with the dual purpose of affecting management practice and publicizing the Sloan School. FY2001 was a very successful year for *SMR,* which undertook a major redesign and editorial enhancement in January 2001, doubled its circulation, and launched a new book series.

The journal finished the year with revenues of $3.5 million. *SMR's* circulation exceeded 50,000, readership grew to 150,000, renewal rates topped 58 percent, and reprints and permissions sales were at all-time highs.

SMR's citation and impact ratings, as measured by the Social Science Citation Index, were also impressive. It ranked fourth among the 61 management journals tracked.

75 percent of articles came from top-20 business schools, including several from MIT faculty. Well-known authors include Sumantra Ghoshal, Christopher Bartlett, Henry Mintzberg, C.K. Prahalad, Clay Christensen, Peter Senge, Constantinos Markides, Lester Thurow, Michael Porter, and J.B. Quinn.

SMR has successfully implemented the first stage of its aggressive growth strategy. The journal will continue to grow circulation, improve its web offerings, and increase advertising, permissions, and reprints revenues in the coming years.

LABORATORY FOR FINANCIAL ENGINEERING

The focus of the Laboratory for Financial Engineering (LFE) is the quantitative analysis of financial markets using state-of-the-art mathematical, statistical and computational models. The LFE's goals are to spur advances in financial engineering and computational finance; and to support curriculum development for financial technology in undergraduate, graduate and executive educational programs.

The LFE has received major funding support for its activities from Merrill Lynch this year as part of the five-year MIT/Merrill Lynch partnership announced in March 1999. As a result, several new research initiatives will be launched, including the following projects: Trading Costs and Liquidity; Global Financial Crises; Psychophysiology of Real-Time Risk Processing; Financial Visualization; and Hedge-Fund Return Dynamics.

Thanks to major funding support from the MIT/Merrill Lynch Partnership, the LFE has been able to expand its research focus in number of new directions, in addition to making progress on several existing projects. In particular, the LFE launched three new initiatives last year: the Risk Preferences Project, the Global Financial Crises Project, and the Marketing by WebMarkets Project. The Risk Preferences Project involves theoretical, empirical, and experimental analysis of the risk preferences of investors, and includes collaborations with cognitive scientists, computer scientists, and professional traders at two local financial institutions. The Global Financial Crises Project is an attempt to develop a systematic framework for understanding the mechanisms by which financial crises in one institution or country is transmitted to others. The Marketing by WebMarkets Project is a collaboration between faculty in the Department of Brain and Cognitive Sciences, Sloan Finance, and Sloan Marketing departments in which artificial financial markets are proposed as a more efficient and cost-effective alternative to standard marketing surveys to elicit consumer preferences.

In addition, there has been considerable progress in each of the existing projects of the LFE: Asset Allocation, Trading Volume, Derivatives, Derivatives Sourcebook, Risk Management, and Nonlinear Financial Time Series.

These projects and their corresponding preprints and reprints, along with LFE staff and affiliated faculty, are described in more detail at the LFE's web site http://lfe.mit.edu/.

The MIT/Merrill Lynch partnership also includes two important educational components: a distance-learning initiative for Merrill Lynch executives and the Financial Technology Option (FTO), a new graduate minor in financial technology that has been jointly developed by the Sloan School of Management and the Department of Electrical Engineering and Computer Sciences in the School of Engineering. The distance-learning program involves the electronic delivery of Professor Andrew Lo's investments course (15.433) to a select group of Merrill Lynch executives over a 12-week period, along with live chat sessions and group projects developed by Merrill Lynch teams. The MIT FTO program's intent is to provide training in financial engineering for MIT graduate students from technology fields such as engineering, math, computer science and media studies. The minor will increase financial applications within the School of Engineering's technology courses and boost the number of technology courses available to MBA students in Sloan's Track in Financial Engineering. This is the second year of the FTO and approximately 35 students have signed up for the option.

Research support for the LFE has been generously provided by a number of industry sponsors and donors. Sponsors include FleetBoston, Gifford Fong Associates, Lehman Brothers, Merrill Lynch, National Science Foundation, Putnam Investments, Silicon Graphics, and Sun Microsystems.

Donors include Harris & Harris Group and Morgan Stanley Dean Witter.

More information about the LFE's research program can be found online at http://lfe.mit.edu/.

Andrew W. Lo

MIT ENTREPRENEURSHIP CENTER

The mission of the MIT Entrepreneurship Center is to train and develop leaders who will make high-tech ventures successful. To that end, we offer educational programs to inspire, educate, and coach new generations of entrepreneurs from all parts of MIT. To support this mission, MIT's Entrepreneurship professors, practitioners and staff teach more than a dozen courses and conduct basic research to enhance our fundamental understanding of the dynamic process of high-tech venture development in the United States and around the world.

The MIT Entrepreneurship Center was launched as an Institute-wide initiative in 1996. At that time, President Vest said, "We must not only be the best. We must also serve as a model for others and ensure that, together, we all make a significant global impact in this vital field." To achieve these objectives set out by our president, we established two goals: to recruit ten leading professors and practitioners and to raise $60 million in endowment to fund their teaching and research.

Since then, our ranks have grown as we continue to recruit world-class educators. In FY2001 we recruited several more experienced entrepreneurs as Senior Lecturers and tenure-track faculty members. We now have 12 professors and 13 practitioners teaching our courses.

During the year, while other schools saw a drop off in entrepreneurship enrollment, the center sustained its rapid growth, increasing student enrollment in entrepreneurship courses while launching new courses, student activities, and faculty initiatives. From 1996 to 2001, student enrollment in entrepreneurship courses grew from 288 to 1475. In the same period, the center increased its recurring course offerings from five to eleven.

Table 2. MIT Entrepreneurship Center Course Enrollment

Course	1995–96	1996–97	1997–98	1998–99	1999–00	2000–01
New Enterprises	70	107	270	180	161	299
Entrepreneurship Lab	20	60	138	150	174	115
Entrepreneurship Without Borders			70	55	55	39
Entrepreneurial Marketing				60	49	118
Entrepreneurs in the Next Economy					125	55
Entrepreneurial Finance					47	115
Global Entrepreneurship Lab						43
Raising Early Stage Capital						25
Business Plans that Raise Money						64
Independent Activities Period	128	170	283	418	369	458
All Others	70	180	165	146	66	179
Total (counting listeners)	288	517	926	1043	1086	1475

In 2001, our faculty launched three new courses: Global Entrepreneurship Lab; an international version of the Entrepreneurship Lab, now in its 6th year; Business Plans that Raise Money; and Raising Early Stage Capital. In addition, we continued to develop our intense, one-week executive education course, Entrepreneurship Development Program (EDP).

Student organizations supported by and housed in the MIT Entrepreneurship Center were recognized as world leaders this year. The MIT $50K Entrepreneurship Competition celebrated its 12th Anniversary with over 108 business plan entries and a new summer breakfast series for start-ups. The MIT-Sloan Venture Capital Conference attracted 500 attendees from over 20 countries.

We continued to expand our efforts to build and engage the alumni community. In addition to regular Entrepreneurship Society functions, the center hosted major networking galas in Austin, Boston (2), Chicago, Manhattan (2), Seattle, Silicon Valley, Washington, D.C., London, UK and Cologne, Germany. The events drew over 2,000 members of the center's network, including MIT and Sloan graduates engaged in entrepreneurial activity.

Our partnership with the University of Cambridge and the ten Scientific Enterprise Centers (SECs) in the UK expanded significantly, catalyzed by the bright leaders of the Cambridge Entrepreneurship Center. During the year, our quarterly meetings with the SECs focused on commercialization of University-developed intellectual property and launching business plan competitions.

Together with leading universities in Taiwan, we prepared a business plan to launch the Asian Entrepreneurship Center.

The center's programs and activities received significant favorable press coverage in *The Wall Street Journal, The Economist, The Financial Times, Fortune, The Boston Globe, Red Herring, Tornado Insider, and Asahi Shimbun,* among others.

On the financial side, endowment pledges of support from entrepreneurial alumni since 1996 have provided $24 million in seed capital toward our goal of $60 million. Eleven corporate sponsors were selected in the upcoming year for their ability to add to our educational programs and assist our students and alumni in starting new technology ventures.

Kenneth P. Morse

MIT PROGRAM ON THE PHARMACEUTICAL INDUSTRY

The MIT Program on the Pharmaceutical Industry (POPI) was founded in 1991 as a research and education program for understanding the structure and dynamics of global pharmaceutical industry, the firms and their suppliers, customers, and regulators.

Currently, more than 10 MIT faculty and 12 outside collaborators from other universities are participating in the research program. Since POPI's inception, some 30 MIT graduate students have completed doctoral work with support from POPI. More than 20 pharmaceutical, biotechnology or other healthcare firms have contributed funding

and/or data for POPI's research or educational activities. As of June 30, 2001, nearly 90 articles and working papers have reported on research conducted by POPI faculty and students.

In 2000–2001, faculty associated with POPI continued research on a number of the managerial and policy issues associated with drug discovery and development, the use of new tools to systematize key aspects of drug discovery, pharmacoeconomics and many other topics.

Recently, the program launched a new research thrust that focuses on the manner in which science and technology are driving change in drug discovery, development, manufacturing and the business of pharmaceuticals. These issues form the basis for the content of the Institute's multidisciplinary academic subject, Principles and Process of Drug Development, taught in conjunction with five POPI-affiliated faculty members. Of particular interest will be how technological changes are impacting the availability of new drugs and the delivery of health care.

Stan N. Finkelstein

PRODUCTIVITY FROM INFORMATION TECHNOLOGY (PROFIT) INITIATIVE

The Productivity from Information Technology (PROFIT) Initiative explores how information technology can enhance productivity in both the private and public sectors. Its research spans diverse areas from finance to transportation, and from manufacturing to telecommunications. Current research efforts include knowledge acquisition (including the extraction of information from paper-based media as well as semi-structured web sources); knowledge discovery (which includes the use of neural network-based data mining techniques); knowledge management and integration (which includes the mapping and assembling of information across departmental, corporate, and national boundaries to suit new conditions and requirements); and knowledge dissemination.

Under the aegis of a broad multiyear agreement with MITRE, significant research was conducted during the year in a number of areas including: data mining; knowledge discovery; semantic web; and knowledge abstraction and dissemination from a future corporate-wide knowledge infrastructure (http://scanner-group.mit.edu/).

Merrill Lynch, Banco Santander Central Hispano, Suruga Bank and Fleet Bank are supporting research on important technologies and strategies for the future of financial services firms, including the development of a prototype Universal Financial Aggregation (UFA) that utilizes the work on web wrapper and context mediation (http://context2.mit.edu/). Some of this work was done in collaboration with MIT's Center for eBusiness. Researchers of PROFIT played a major role in organizing the ACM Knowledge and Data Discovery (KDD) Conference in Boston (http://www.acm.org/sigkdd/kdd2000/) in August 2000, the IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises (WETICE) at MIT Sloan School in June 2001 (http://sec.femto.org/wetice-2001/), and the Information Quality Conference at MIT in November 2001 (http://web.mit.edu/tdqm/www/IQConference.html).

During the year, members of PROFIT Initiative became founding-members of the SSPARC Consortium organized by the MIT Department of Aeronautics. The work at PROFIT was in the areas of Design Rationale; Collaborative Design; Data Mining and Knowledge Repositories to enable quicker, better, and cheaper design, development, and manufacture of spacecrafts (http://leanair4.mit.edu/docushare/default.htm).

More about the PROFIT Initiative can be found online at http://mitsloan.mit.edu/research/profit/profit.html/.

SYSTEM DYNAMICS GROUP

The System Dynamics Group was founded by Professor Jay W. Forrester in the early 1960s to pursue research in the area of understanding the importance of structure in the behavior of complex systems, particularly corporate structure. Currently, we are studying three areas.

The National Model Project, a large computer model, strives for a better understanding of how the U.S. economy works, and is used to help analyze the effects of proposed economic policies. The group uses the National Model to capture the interactions of local structures and decision-making policies, building a bridge that joins microstructure with macrobehavior. Corporations and private individuals fund this research which is directed by Professor Jay W. Forrester.

The System Dynamics in Education Project was established in 1990 with private funding. Writing the Road Maps series is the main area of activity. Road Maps is a self study guide for learning system dynamics which is available free at http://sysdyn.mit.edu/. The series of self-study chapters use modeling exercises and selected literature to provide a way of learning about the principles of system dynamics and it's many uses. More recently, a distance learning course in system dynamics called The Guided Study Program has been offered using Road maps as the core text. This is a large UROP effort involving approximately ten students per term. The educational work of the System Dynamics in Education Project is headed by Professor Jay Forrester.

The Improvement Paradox: Designing Sustainable Quality Improvement Programs is directed by Professor John D. Sterman. With initial funding in the 1990s from an NSF grant, the project studies the design of sustainable quality improvement programs. In the past, many firms abandon TQM programs due to lack of perceived impact on

profitability, even after they experience a significant increase in performance. Through the development of formal models and original case histories, the group seeks to identify the critical interactions between quality programs and a company's other organizational structures. A number of papers on this work are available from http://web.mit.edu/sdg/www/. Corporate sponsors have contributed additional support.

John D. Sterman, Nan Lux

ADMINISTRATION AND SERVICES

RESOURCE DEVELOPMENT

Highlights from the FY2001 include the following:

- The Alumni Relations and Resource Development Offices were further integrated into a larger and more efficient operation. Eliza Dame was hired as Director of Alumni Relations, and Bob St Cyr became Sloan's first Director of Corporate Relaitons.
- The new Director of Corporate Relations, Bob St Cyr, initiated the development of a Corporate Strategy for the School.
- About 700 alumni and their guests attended their class reunions, 30 percent more than the record breaking, previous year.
- More than $107 million has been raised to support Sloan's priorities and projects in MIT's $1.5 billion capital campaign, with 3 full years remaining in the drive.
- FY2001 recorded more than $17 million in cash and almost $28 million in cash and pledges—another great fundraising year.
- The Sloan Annual Fund raised almost $2.0 million in unrestricted funds, while an additional $350,000 supported the School's Minority Fellowship program.
- 7 Sloan Masters Reunion Class Gift Campaigns were run: each class raised considerably more funds. Sloan's very young class reunion gift program is growing very well.

ALUMNI RELATIONS

The first six months of the year were months of maintaining the status quo (...at best, keeping the boat floating at worst) as there was no director during those first crucial planning months of the fiscal year. The second half of the year 2000–2001 was one of studied assessment, analysis, re-structuring, and re-building and re-staffing all the while managing a program of alumni relations.

This year brought changes in many areas.

- New positions needed to be created and filled, existing positions needed re-definition, and staff needed philosophical repositioning and training. This was completed.

- Old ways of thinking about the purpose for an alumni relations office needed to be brought up to date and agreed upon. A strategic plan as well as a tactical plan reflecting these new ideas needed to be developed, written, and implementation begun. As a result, priorities needed to be re-defined. This has been completed.

- New programming with strategic and fundamental links to the goals and priorities of Sloan needed to be set in motion and they were. In addition, a solid foundation for the 50th Anniversary activities was put in place—knowing that the activities for the 50th will impact the further direction for alumni activities at Sloan. Plans for the 50th are well underway.

- Few if any systems were in place for tracking alumni activity, volunteer activity, training, or assessment. What was in place was inconsistent. All systems are "under construction" or "under renovation." Stay tuned.

- Technology continues to be an area of great excitement and great frustration. The past year was no exception. Much of the promotion for reunion was electronic and done with great success. Many of the club events were successfully promoted electronically. (However, with only about 50 percent of alumni on the database with e-addresses, this method of promotion is far from ideal.) Club tools, the answer to all of our prayers, went out of business. EFL is further along in the process of being available to all—we look to next year for implementation. Instant "communication" between the Sloan alumni database and the MIT alumni database (the database of record) is still outside of our grasp. On line registration continues to elude us. We are able now to provide on line payment but have yet to implement full on line registration functionality. Again, we look enthusiastically to this coming year for all of these functions. These areas of technological tracking and information gathering and decemination will provide Sloan with greater and more accurate data regarding the nature and degree of its alumni activity and interest. Sloan Space is still visible on the horizon but will not be fully operational for alumni activity with our resources to support the demand. As with most things in life, getting there is always harder than anticipated.

The Year By Numbers

During a year of change alumni activity goes on and the news is good.

Reunion 2001
Reunion 2001 was by far our staff priority and the numbers speak to the success of all involved, staff and volunteer alike. Numbers were up in both attendance and in reunion giving. Volunteer committees were strong and effective, new and old staff preformed with skill and professionalism.

Feedback from attendees was without exception favorable. Back to the classroom continues to be the biggest sellout (underscoring that faculty participation is critical to a successful alumni program) along with Sloan's traditional gathering, the c-function.

Geographic Programs
With new staff, a new philosophical and collegial approach, and the support of many newly identified and eager volunteers, next year is the year for strategically building our geographic programs. We are building an industry/career-based approach that we think will be more attractive to our constituency than the more traditional strictly geographic approach. However, 2000–2001 was a year of successful and global activity.

FY1998–FY2001 FUNDRAISING TRENDS
The Resource Development (RD) team now features three separate, but inter-related groups, namely: Principal/Major Gifts headed by Margaret Keller; Annual Fund led by Lori Correale and Corporate Relations managed by Bob St. Cyr.

The RD team is focused on MIT's recently launched $1.5 billion Capital Campaign, featuring Sloan's new building and Entrepreneurship Center as fundraising priorities. We have helped raise more than $107 million since the beginning of the counting period, FY1998.

FY2001 cash receipts and written pledges make this another very successful year. More than $17 million in cash and about $28 million in cash and pledges were recorded.

During FY1998–FY2001, the Dean has increased staffing in OACR by seven in order to meet the growing needs of alumni constituencies and fundraising. The emphasis on building a class reunion-giving program is new but is paying off. FY2001 Class Reunion results were double the previous year's. The proposed Sloan building complex; finding a naming donor for the Entrepreneurship Program; and unrestricted funds remain Sloan's top 3 fundraising priorities.

"Unrestricted" funds have become increasingly important while more difficult to raise. During FY2001 OACR raised about $2.3 million, which was a a very good result considering several hundred thousand dollars were rasied from annual donors to support the Sloan Building Complex. The FY2001 results were largely a result of successes in raising unrestricted gifts in the $25,000–$500,000 range from about 12 alumni.

PRINCIPAL AND MAJOR GIFTS
This was a very good year for growth in the Principal and Major Gifts program. The number of gifts in FY2001 of $50,000 or more (including gifts from individuals through corporations or foundations) increased 22 percent from FY2000. The Dean and other senior staff cultivated and solicited about 1000 alumni and friends for financial support for both restricted and unrestricted priorities. Most notably, we solicited and closed on a $5,000,000 gift to name the Deanship, a $3,000,000 for a professorship, and three gifts to the new Sloan Building ranging from $378,000 to $99,630.
A great deal of time was spent this year preparing individuals for an upcoming solicitation for the new Sloan facilities. We have more than 10 individuals ready to be solicited at the six or seven figure range to support the new Sloan Complex once we have the naming opportunities list. In the meantime we have supported the leadership Sloan Annual Fund drive and Class Reunion Giving program by making dual solicitations of major gifts alumni prospects.

This year we also increased our interaction with the Office of Campaign Gifts (OCG), assigning Sloan prospects to Major Gift Officers in OCG and working to support their efforts. While most of these are still in the cultivation stage, gifts from several of these prospects should materialize after we have a Naming Opportunities list.
With the focus on the Principal and Major gifts area on the new Sloan Complex, we have been somewhat successful soliciting building gifts with the promise of a future naming opportunity, but on a very limited basis. We are confident that once that is in place, there are 10–15 people who would be ready for an immediate solicitation. To date we have raised $32,000,000 for the Sloan Building Complex in cash and pledges

The Sloan Annual Fund, Dean's Fund for Innovation Reunion Giving Programs which make up our overall alumni giving program continue to drive our increases in the unrestricted gift revenue the Sloan School needs to stay competitive. We reached a new high of $2.2M in unrestricted from all sources in FY2001 with the majority of these funds coming from individuals.

We continued to expand our Annual Fund Program of direct mail, telemarketing and personal solicitation. We increased our direct mail marketing to approach new, under-developed constituencies such as our international graduates and our non-donors with new, segmented appeals. We also expanded our use of email solicitations to renew our annual donor pool. Our fall volunteer phonathon program continues to bring on a large portion of our

unrestricted dollars and the number of students and alumni who participate as volunteer callers increased this year. We made good use of MIT's paid student caller program (Tech Caller) to make in-roads into our population of non-donors. We also continued our Dean's Fund for Innovation Program, which markets unrestricted needs to potential leadership donors ($1,000+) with great success.

We conducted reunion class gift campaigns with the Sloan Master's Classes of 1996, 1991, 1986, 1981, 1976, 1966, and 1961. Each of these classes substantially increased their dollars contributed and donors participating over what each of these classes normally gives to the Sloan School in a given fiscal year. The standout this year was the Sloan Master's Class of 1996. This class increased its overall dollars contributed by $1,140 percent and their class participate rate in giving from 27 percent to 37 percent. We will continue our strategy of focusing on approximately 10 reunion class gift campaigns per year as a means to systematically increase the annual contributions of our graduates to the Sloan School. However, since we only began truly focusing our efforts on reunion giving with appropriate staff and resources in FY1990, we must go through a full five-year cycle, which will be achieved in FY2004, to truly see the impact of our efforts.

Corporate Relations
The inaugural year of Sloan's Office of Corporate Relations was dedicated to three major initiatives designed to build a foundation for moving ahead with a Sloan School corporate relations program and strategy.

The first initiative focused on gathering baseline data and information from external and internal sources to answer key questions to be used to inform Sloan's approach to the corporate relations work. For example:
- How do other business schools' approach their corporate relations activities?
- Who are Sloan's key corporate sponsors?

The second initiative involved implementing an X Sloan (pilot) approach to serve (improve communication and collaboration) Sloan's key corporate sponsors. The pilot focused on six companies and involved monthly meetings of the senior staff across Sloan (CDO, MBA Office, Exec Ed, Research Centers, Alumni Relations, SMR) and MIT's OCR (ILP). The pilot provided a forum where Sloan program directors came together to review and coordinate a company's multiple interests and engagements across Sloan. Newly formed relationships among Sloan colleagues fostered increased teamwork/work satisfaction.

The third initiative involved a variety of meetings and staff work by the Director with Sloan and MIT colleagues on behalf of Sloan's key corporate sponsors. Visits to campus were planned and hosted, executive speaking engagements were arranged, exploration of research interests, and assessment of education needs and recruiting strategies discussed; and staff support was provided for the DAC, Alumni Reunion.

SLOAN EDUCATIONAL SERVICES
Sloan Educational Services (SES) manages the infrastructure upon which Sloan's academic mission is carried out. The SES team prepares the space (facilities work), arranges for the players (faculty and course scheduling, student registration, student advising, program support), and oversees information flow (internal communications, liaison with MIT Registrar, grades, evaluations).

Our team oversees all registration-related services provided to over 1100 Sloan students; manages the web-based course prioritization system used by more than 2,000 MIT students, equitably resolving difficult supply and demand issues in a department with increasingly popular classes and already high enrollments; handles scheduling of the more than 200 class sections and recitations offered each term; maintains Sloan facilities; and produces both online and paper resource materials for the School (including the PhotoBook, Student Directory, student biocards, and weekly News@Sloan newsletter).

Staffing changes this past year continued the organizational restructuring begun last year in Sloan Educational Services, with a focus on processes, systems and enhanced customer service. In addition to last year's emphasis on enhanced advising and support to the MBA team and students, there is now strengthened assistance to executive education students, teaching assistants and faculty. The MBA core continues to undergo modifications, affecting course scheduling, registration and advising. In addition, SES staff participated in the Dean's Office student revenue project, which will greatly impact the Sloan Course prioritization system. As in previous years, Sloan Educational Services continues to refine its analysis of bidding data to assist Sloan's deans and faculty on issues of demand regarding course and section offerings and teaching load plans.

Facilities management remained a high priority. Sloan Educational Services staff oversaw the renovation of multiple Sloan spaces and the moves of our faculty and staff. Most recently our group managed the relocation of Sloan's Entrepreneurship Center to provide additional student study space. SES staff continues to work collaboratively with the Sloan New Building Committee, participating on teams and providing necessary data as a central source of Sloan operations.

Sloan enrollment remains high and Sloan classes continue to attract record numbers of MIT students from all departments. The School continues to explore ways to forecast and meet demand, including additional sections of classes, videotaped sessions, special seminars, and new joint agreements with other MIT departments. It is our role

to balance precious resources such as classroom space and faculty teaching time across all programs. Finding new ways to track and analyze data is vital in this all-School effort. SES staff continually strives to provide the highest possible levels of service to all constituents on a daily basis while striving to implement continuous improvement.

Goals for 2001–2002 include completely revising the class scheduling process; overhauling and automating the teaching evaluation process; designing an auditing database for student record maintenance; bringing student publications on-line; building a strong SloanSpace web presence to better support Sloan students, faculty and TAs; renovating the Sloan Lobby and enhancing current facilities even as we plan for those of the future; and, as already mentioned, constantly improving customer service. As always, we will continue our work with students to explore their changing needs and collaborate on creative methods of meeting them.

More information about this department can be found online through the Students tab at http://mitsloan.mit.edu/.

Debbie Shoap Berechman

THE LEMELSON-MIT PROGRAM FOR INVENTION AND INNOVATION

The Lemelson-MIT Program is a nationwide educational initiative promoting invention and innovation through annual awards, an ongoing outreach campaign, and MIT courses that teach invention and entrepreneurship. Each year the program presents inspirational role models in science, engineering, technology, and entrepreneurship through its $500,000 Lemelson-MIT Prize, $30,000 MIT Student Prize, High School Invention Apprenticeship, and Lifetime Achievement Award. The program's goal is to encourage young people to pursue careers in these areas as well as to raise public awareness of the critical role inventor-innovators play in society.

Winners of the 2000 Lemelson-MIT Awards are futurist and pattern technologies pioneer Raymond Kurzeil (Prize); inventor of micro-fabrication technologies and Media Laboratory graduate Brian Hubert (Student Prize); North Dakota native and recent high school graduate Jordan Sand (Invention Apprenticeship); and inventor of the magnetic resonance imaging (MRI) scanner Raymond Damadian (Lifetime Achievement Award).

The program presented exciting inventor-innovator role models through numerous articles, including pieces in *USA Today, Business Week, The Industry Standard, Investor's Business Daily, San Francisco Chronicle,* and the *Boston Globe*. Its "Invention Dimension" web site was featured in *Popular Science's* October cover story "50 Hot Sci-Tech Sites," and topped the "Inventions & Labs" category. The program also conducted joint outreach programs with the Smithsonian's National Museum of American History, the MIT Museum, and the Edgerton Center.

Through funding to courses in the schools of Engineering and Sloan, the program helped stimulate the creation of new inventions in a team-based environment at both the undergraduate and graduate levels (2.009 Product Engineering Process and 2.783J Product Design and Development), as well as helped encourage entrepreneurial student talent through the Center for Entrepreneurship's internship program (15.399 Entrepreneurship Lab). Selected student teams from 2.009 presented their prototypes in Washington, DC at the Smithsonian Institution in March.

As of July 1, 2001, the Lemelson-MIT Program moved administrative homes from Sloan to the School of Engineering. Additionally, Merton Flemings, Toyota Professor of Materials Science was appointed Faculty Director.

This coming November, the Program will release *Inventing Modern America: From the Microwave to the Mouse* (MIT Press). *Inventing Modern America* is a highly pictorial, museum-quality book portraying the lives of 35 American innovators of the past century through lively vignettes. Lemelson Professor of Management and Economics Lester Thurow wrote the book's foreword, and science historian and writer James Burke contributed introductions to the book's five sections. A companion web site will go live in October at http://www.inventingmodernamerica.com/.

For more information on the book and other upcoming program activities can be found at the Invention Dimension web site at http://web.mit.edu/invent/.

Annemarie Amparo

SLOAN COMMUNICATION OFFICE

The Sloan Communication Office develops and implements innovative, multimedia approaches to market Sloan as a world-class business school. The four-person staff designs and executes a global media strategy, coordinates and manages Sloan's Web presence, provides communication support for the Dean's Office, publishes a magazine for alumni and other constituencies, and develops and produces Sloan's marketing collateral.

Communication activity at Sloan continued to increase in FY2001 and is expected to grow further in FY2002. The added load involves ongoing management and development of the web, increased media coverage, regular publication of *ROI* magazine, increased support for the dean (especially with international visits to alumni and the media), support for the capital campaign and increased coordination with resource development, alumni relations, and technology services.

Media inquiries and coverage were up again from last year. Press clippings climbed to over 700, a 20 percent increase from the previous year. There were 800 media contacts made throughout the year, up from 600 the previous year. More than a third of the contacts were made electronically with MediaMap, an online media database and e-mail distribution service added in January 2001. Email invitations to Entrepreneurship Center galas, dean visits and media relations visits throughout the U.S. and the U.K. garnered nearly 300 new media contacts.

Media support and department presence was provided for the dean and Entrepreneurship Center events in New York, Chicago, Austin , Seattle, Silicon Valley, Washington, D.C., and London this past year. Assistance was again provided to several student groups' media outreach efforts. Student organizers for the California Tech Trek, Latin American Conference, International Trips, eBusiness Awards and $50K Entrepreneurship sought media advice and help. Because of the growing student demand for media help the department conducted a media training class for student club and PR team leaders last fall.

The Sloan web site, launched in February 1999, enjoyed many updates and improvements—both in content and organization—in fiscal 2001. The Communications Office regularly updates the features on the section fronts and now provides web development and maintenance support to all Sloan departments. The use of evergreen marketing copy and constant updating of photos helps keep the site fresh, as well as publicize the vibrancy of student and academic life at the School. In addition, we have initiated a redesign of the MBA admissions site, which serves as Phase I of a multiphase plan to eventually update the entire Sloan site.

The alumni magazine, MIT Sloan *ROI*, continues to be published three times annually, supported by an online version located on the Sloan web site. A reader survey conducted in fiscal 2001 yielded positive feedback from alumni and other constituencies. Goals for fiscal 2002 include more frequent email updates to alumni featuring Sloan news and alumni profiles, as well as increasing alumni traffic to the web site.

The Faculty Expertise Guide is in the process of being updated with a goal of fall 2001 publication. The online PeopleFinder will continue to support the print guide with updated faculty and staff profiles. The careful thought put into developing the infrastructure and people database now makes it possible for faculty to easily update their profiles. It also gives the Communications Office—and the rest of the community—access to the most updated information.

The Wall Street Journal conducted its first ranking of top business schools this year adding another survey to the more than 20 the department already responds to. In Business Week's biennial 2000 MBA survey, out last October, Sloan made a quantum leap from number 15 to number 4.

The overall goals for FY2002 are to continue to manage the increasing global coverage of Sloan and its activities and ensure that the School's key messages are well represented, as well as to work with the various constituencies to create cohesive Sloan messaging in print and on the web. With the dean's visibility and his visits worldwide along with the capital campaign, we expect media coverage at least to double again this coming year.

SLOAN TECHNOLOGY SERVICES TECHNOLOGY SERVICES

Sloan Technology Services (STS) supports the computing needs of faculty, staff and students at the Sloan School. STS successfully completed the following major initiatives during FY2001:

- Wireless. With the assistance of MIT network services, STS installed high speed 802.11 wireless services in all Sloan Buildings. Wireless access is now the preferred mode of connectivity for Sloan laptop users.
- SloanSpace. Launched comprehensive web information portal with features for course management and collaborative communities. Over 70+ courses utilized SloanSpace during Spring 2001. Currently, there are over 4000 registered users of SloanSpace.
- Sloan Email For Life. Students and alumni have requested a Sloan branded "persistent" email address. Launched EFL service in Spring 2001. All entering students and alumni now receive an email address of the form userid@sloan.mit.edu.
- Web Infrastructure. To enhance security and reliability, migrated all Sloan web servers from Win servers to Linux. Migrated Cold Fusion Application server and Oracle database from Win servers to Solaris.
- Educational Technology. Participated in numerous educational technology experiments, including an Executive Education course for Merrill Lynch.
- Ecommerce. In cooperation with MIT IS, installed ecommerce system for processing alumni reunion credit card transactions.

Plans for FY2002 are to:

- Continue to extend SloanSpace functionality by adding support for research dissemination and alumni communities;
- Develop Sloan Datamart as the foundation for executive decision making;
- Complete Alumni Database Synchronization Project with MIT alumni services; and
- Migrate Sloan web infrastructure from Cold Fusion to J2EE (Java Enterprise Edition).

Alfred Essa

DEAN, SCHOOL OF SCIENCE

The School of Science at MIT continues to play a leadership role, both nationally and internationally, in science education and research. Our graduate education programs are ranked among the very top in all the disciplines of the School by a variety of organizations. Maintaining that high standard is the highest priority of the faculty and administration in the School.

The School of Science continues to do a major part of the undergraduate education at MIT. Biology has grown in the last decade to become the second largest major (after EECS) at the Institute. In addition, the Departments of Mathematics, Physics, and Chemistry have some of the largest student contact hours. This overall excellence of teaching is exemplified by the number of MacVicar Fellows in the School (43 percent of the total). The School of Science Teaching Prize for Undergraduate Education for 2000–2001 was awarded to Professor Steven Pinker of BCS. There was no award made for gradudate teaching that year.

The quality of an academic unit such as the School of Science is determined by the caliber of the faculty involved. One of the highest priorities of the School administration is to support our existing outstanding faculty and to recruit to MIT exceptionally talented young researchers and educators, especially underrepresented minorities and women, to our faculty. In 2000–2001, eleven new faculty joined the School as Assistant Professors, including one female and three underrepresented minorities. In 1999–2000 fifteen new faculty joined the school which included two female full professors, one female assistant professor and one underrepresented minority assistant professor.

Our faculty received many honors and awards during the past year, both external and internal. Of particular note, is the induction of Professor Robert Weinberg into the American Philosophical Society and the Institute of Medicine of the National Academy of Science, the award of the Young Investigator Award of the Society for Neuroscience to Professor Earl Miller, the American Chemical Society Award in Analytical Chemistry to Professor Klaus Biemann, and the Benjamin Franklin Medal in Physics of the Franklin Institute to Professor Alan Guth, the election of Professor Barbara Imperiali and Professor Stephen Buchwald to the American Academy of Arts and Sciences, and the election of Professor Dietmar Seyferth and Professor Rainer Weiss to the National Academy of Sciences.

The many new research initiatives and fundamental discoveries that occurred in the various departments and laboratories of the School of Science are discussed below in the reports of those units.

Fund raising in the School of Science reached all time highs over the past few years with a total of new gifts and new pledges exceeding $35M in FY2001.

ACADEMIC PROGRAMS

There were 767 undergraduate majors in the School of Science during the past academic year, a 2.3 percent decrease from the previous year. The number of minority student majors at the undergraduate level changed as follows:

Blacks	37 to 30 (18% decrease)
Hispanics	61 to 53 (13% decreas)
Native Americans	13 to 11 (15% decrease)
Asian Americans	205 to 207 (1% increase)

The number of minors awarded in the School of Science in 2000–2001 was 65. The female undergraduate population decreased marginally from 422 to 409. Twenty-four percent of the Institute's upperclass undergraduates were enrolled in the School of Science.

Graduate enrollments in science increased from 974 to 1034. The total enrollment represents 18 percent of the graduate population at MIT. The number of minority students at the graduate level changed as follows:

Blacks	11 to 12 (9% increase)
Hispanics	17 to 14 (18% decrease)
Native Americans	2 to 3 (50% increase)
Asian Americans	55 to 61 (11% increase)

The number of female graduate students increased from 319 to 323 (1.3 percent). The overall percentage of female graduate students remained at 31 percent.

The 253 faculty members in the School this past year represents a one percent decrease from the previous year. The undergraduate student-to-faculty ratio was three to one, and the graduate student-to-faculty ratio was four to one.

RESEARCH VOLUME

The FY2000 research volume was $120.7 million, a $3 million increase over the FY1999 research volume. This figure does not include the significantly increased research volume by MIT faculty at the Whitehead Institute (>$30M), HHMI faculty (>$10M) as well as the research volume associated with School of Science research carried out in the interdisciplinary laboratories reporting to the Vice President and Dean for Research.

Robert J. Silbey

DEPARTMENT OF BIOLOGY

The Department of Biology has 65 active faculty members; 15 are located in the Whitehead Institute, 13 are located in the Center for Cancer Research, five are joint appointees with the Department of Brain and Cognitive Sciences, one is joint with Chemistry, and one is joint with the Department of Civil and Environmental Engineering. Two faculty members also hold appointments in the Division of Bioengineering and Environmental Health. Including active Emeritus faculty, the department includes three Nobel Laureates, 21 members of the National Academy of Sciences, and 13 investigators of the Howard Hughes Medical Institute. The department has a preeminent national and international reputation in research and teaching, and has been a leading contributor to the development and application of cellular and molecular biology.

EDUCATIONAL ACTIVITIES

In the past year, 311 undergraduates registered as Biology majors. Biology remains the largest undergraduate major in the School of Science. The Bachelor of Science in Biology degree was awarded to 107 students this past year: 90 in the regular Course VII Program and 17 in the VII-A Program.

A number of Biology majors received awards in 2000–2001. Rebecca M. Grochow received the William L. Stewart J. Award for outstanding contributions to co-curricular activities. Rebecca also received the Frederick Gardiner Fassett, Jr. Award presented to the members of the Inter-Fraternity council who have unselfishly demonstrated the qualities of spirit, dedication, and service in furthering the ideals of MIT fraternity and sisterhood. Erica Lee received the Priscilla King Gray Award for Public Service, in recognition of an undergraduate exceptionally committed to public service at MIT and its surrounding communities. Morgan Royce-Tolland received the Laya W. Wiesner Award, given to an undergraduate woman who has most enhanced MIT community life. The Biology Department presented the following students with awards at the annual Senior Dinner: Christopher D. Allen received the Whitehead Prize, awarded to a student showing outstanding promise for a career in biological research; Saria Hassan received the Ned Holt Prize, given to a Biology major who demonstrates excellence in scholarship and service to the Department and the MIT Community; Karolina Fraczkowska was the recipient of the Salvador E. Luria Prize, awarded for outstanding scholarship and research of publication quality; Hemaluck (Lynn) Suwatanapongched and Trushar Patel were the recipients of the John L. Asinari Award in recognition of outstanding undergraduate research in the field of life sciences. Yevgeniya Nusinovich received a Chemistry Service Award for significant service to the Chemistry department. Four Ilona Karmel Writing Prizes were awarded to Biology students: Hilarie C. Tomasiewicz received first prize in the Boit Manuscript Poetry category. Stephanie W. Chow received the Ellen King Prize for Freshman Writing. Helana Kadyszewski received the second-place prize in the Robert A. Boit Writing competition. Kanika Agrawal received first prize for her poetry and also received Honorable Mention in the short story competition. Shanice V. Williams received the Joseph D. Everingham Award for a single creative outstanding performance or notable creative accomplishment in theater arts by a graduating senior. The following 19 students were elected to Phi Beta Kappa: Christopher D. Allen, Connie Y. Chang, Eric C. Chang, Jennie J. Cho, Riaz S. Dhanani, Karolina Fraczkowska, Zofia K. Gajdos, Saria Hassan, Samantha Hess, Kathie P. Huang, Sam Jahanmir, Murat E. Kara, Tamara N. Oei, Priya M. Rajendran, Morgan Royce-Tolland, Nina K. Shah, Derek G. Southwell, Ryan K. Swenerton, and Binbin Wang.

From July 1, 2000 to June 30, 2001, the Department awarded 37 Ph.D. degrees and one S.M. degree. Five Ph.D. and two S.M. degrees were awarded in the Joint Program in Biological Oceanography with the Woods Hole Oceanographic Institute (WHOI). The maximum number of Ph.D. candidates registered in the Biology Department in 2000–2001 was 224, with another 38 in the Joint Program. The incoming class for Fall 2001 will be 34 students, with an additional 4 students in the Joint Program.

RESEARCH

The research activities of the department cover most areas of modern biology including biochemistry, genetics, microbiology, cancer biology, cell and developmental biology, immunology, neurobiology, virology, and structural biology. The research achievements over the last year are too numerous to be listed here. There were, however, several significant advances in the areas of human health and disease. The Whitehead-MIT Center for Genome Research, under Eric Lander, made the largest contribution to the Human Genome Project that assembled the human genome this past year. The Horvitz lab discovered a receptor that responds to serotonin, throwing light onto how drugs, such as Prozac, affect the brain. Additionally, the Horvitz lab also found a protein that is part of a cell's natural suicide machinery, which might offer targets for drugs that can prevent cell death related to heart attacks, strokes, or Alzheimer's disease. Scientists from the Jaenisch lab participated in cloning research showing that an egg cell can reprogram an adult cell back to its embryonic state. The Constantine-Paton lab uncovered a new control system for a key receptor of nerve cell signals. This discovery in the area of brain development may lead to advances in the clinical treatment of a variety of neurological dysfunctions. Peter Sorger's lab has identified the human homolog of a yeast checkpoint kinase and shown it is part of the kinetichore of improperly aligned human chromosomes. Moreover, they have shown that this kinase phosphorylates APC, a kinetichore associated protein that is mutated in almost half of all tumors of the colon. This result provides an explanation for the chromosome instability phenotype associated with these tumors. Loss of the Rb tumor suppressor function results in tumor formation and cell death, but Jackie Lees and her colleagues have shown that disruption of the E2F3 gene in mice that lack Rb prevents these processes. In more basic research, Tania Baker's lab has discovered a novel protein that modifies the specificity of intracellular proteases, and Alan Grossman's lab has shown that variations in intracellular protein levels arise from translational rather than transcriptional inefficiency. Finally, David Bartel's lab has evolved

an RNA enzyme that functions to replicate RNA–providing key support for the feasibility of the RNA-world hypothesis.

PERSONNEL

Professors Chess and Gertler were promoted to Associate Professor without Tenure. Professors Chen, Lees, Sorger and Wilson were promoted to Associate Professor with Tenure.

We are pleased to report that Amy Keating has accepted a faculty position in the department. She will be joining the Biology Department as an Assistant Professor. We are also pleased to welcome Morgan Sheng, who will have a primary appointment in the Department of Brain and Cognitive Sciences and a secondary appointment in the Department of Biology.

Two new faculty members, Luk Van Parijs and Michael Yaffe, arrived during the past year to set up their laboratories within the Center for Cancer Research. They joined the department as Assistant Professors.

Tyler Jacks took over the position of Director of the Center for Cancer Research. Jacqueline Lees was named the Associate Director of the Center for Cancer Research.

Arnold Demain has retired after 32 years in the department. Sheldon Penman has also retired, after 36 years in the department.

Honors and Awards

Tania Baker received the American Society for Microbiology Eli Lilly award and the MIT School of Science Teaching Prize for Excellence in Undergraduate Education. Steve Bell was awarded the American Society for Biochemistry and Molecular Biology-Schering Plough Scientific Achievement Award. Chris Burge was awarded the Overton Prize for Computational Biology. Paul Garrity was named Whitehead Career Development Professor. Frank Gertler received the Keck Foundation Distinguished Young Scholars Award. H. Robert Horvitz received the Feodor Lynen Medal (University of Miami). Gobind Khorana received the Centennial Honorary Degree from Rockefeller University at their Centennial Celebration and Commencement, June 2001. Monty Krieger was appointed as a Thomas D. and Virginia W Cabot Professor. Eric Lander received an Honorary Doctorate from the Medical College of Wisconsin. Troy Littleton was named a Searle Scholar. Harvey Lodish was named Chair, Section 22, Cellular and Developmental Biology, National Academy of Sciences. Terry Orr-Weaver was appointed to the National Institutes of Health, General Medical Sciences Advisory Council. Phil Sharp received an Honorary Doctorate, Northern Kentucky University, and received the Walker Prize from the Boston Museum of Science, Robert Weinberg was inducted into the American Philosophical Society and became a member of the Institute of Medicine, National Academy of Sciences.

Raymond and Beverley Sackler established the Sackler International Lecture in the Life Sciences through a donation to the department. The inaugural lecture will be held this year.

The department was the recipient of proceeds of the sale of stock from, Praecis Pharmaceuticals, a company which was in part founded by Malcolm Gefter, Professor of Biology since 1972, and now Emeritus Professor. These funds will be used to establish fellowships to support six to seven first-year graduate students. The new fellows will be known as Praecis Presidential Fellows.

The Schimmel Scholar, established by Paul and Cleo Schimmel, provides four years of funding to an outstanding woman graduate student. Harotka (Xu) Godzina was named the first Schimmel Scholar last year. Xu graduated from Rice University with a B.A. in Biochemistry. Stephanie Xie is the second Schimmel Scholar. She graduated from the University of Chicago with a BA in Biology in 1999.

More information about the Biology Department can be found online at http://mit.edu/biology/www/.

Robert T. Sauer

DEPARTMENT OF BRAIN AND COGNITIVE SCIENCES

The human brain is the most complex, sophisticated, and powerful information-processing device known. To study mechanisms of the brain and mind, the Department of Brain and Cognitive Sciences at the combines the experimental technologies of neuroscience and psychology with the theoretical power of computational methods and cognitive science. The department's research focuses on several themes, with each studied at multiple levels of analysis using cellular, systems, computational and cognitive approaches.

FACULTY RESEARCH ACCOMPLISHMENTS

Brain Mechanisms Of Vision

Bart Anderson's lab has made significant theoretical advances toward understanding the mechanisms underlying depth and surface. They have demonstrated that motion sensitive mechanisms play a critical role in solving the binocular matching problem and also discovered the critical image properties that human observers use to compute the opacity and lightness of partially transparent and translucent surfaces. They are using these discoveries to develop a quantitative theory of this perceptual ability.

Nancy Kanwisher's lab has employed a new event-related fMRI adaptation paradigm to characterize visual representations in a variety of different cortical areas, and have used this technique to demonstrate a cortical area that represents perceived shape. Second, they have discovered a new category-selective cortical region that responds to the appearance of the human body. They also collected both behavioral and fMRI data that argue against the long-held assumption that image segmentation is distinct from, necessary for, and prior to object recognition.

Peter Schiller's lab examines the neural control of visually guided eye movements and the neural mechanisms of depth perception. They have reported several significant new findings about the manner in which the occipital, parietal and frontal cortices contribute to eye-movement control in the primate. They characterized six cortical areas that play a central role in directing the eyes to selected visual targets.

Gerald Schneider's research group has developed methods for obtaining an unprecedented amount of axon regeneration in the visual pathway of the adult brain, with return of visual function in animals that had been blind after brain injury.

To study the limits of human visual recognition processes, Pawan Sinha's laboratory established data that benchmarks performance of human observers on several ecologically important recognition tasks. They constructed both a scheme for encoding impoverished image structure and a computational framework. To then determine if these limits serve as quantitative markers for diagnosing visual disorders, they developed and clinically tested an experimental paradigm as a tool for diagnosing subtle forms of visual agnosia and for evaluating changes in perception caused by abnormal developmental histories.

Learning And Memory

Research in Emilo Bizzi's laboratory has been aimed at describing plasticity in the motor cortex and in assessing the feasibility of a remotely supervised, computer-enabled physical therapy device, administered over high-speed telecommunications for patients recovering from stroke.

Suzanne Corkin's laboratory strives to elucidate the cognitive and neural organization of human memory systems. In patients with Alzheimer's disease (AD) or Parkinson's disease, their results indicate that the respective neuropathological changes exert dissociable effects on working memory capacities. In healthy volunteers, aging disturbs the frontal lobe contribution to semantic processing (semantic encoding and categorization easily verbalized material), whereas AD also disturbs the temporal lobe contribution (perceptual encoding and analysis; representation of long-term semantic knowledge).

Ann Graybiel's lab has carried out ensemble recording from multiple neurons in the neocortex and basal ganglia of rodents and monkeys. In the rodents, they found large-scale changes in neural activity in the striatum as animals learn in procedural learning tasks. They also found that these changes in neural activity are reversed when the animals are then placed in situations in which performing the procedure is no longer rewarded. However, when reward is again instated, the neural activity changes begin to return to the cortical-basal ganglia network. A similar result was found in monkeys. These studies demonstrate a remarkably tight brain-behavior relationship during the course of learning.

Earl Miller's lab studied the ability to group stimuli into meaningful categories. They trained monkeys to categorize computer-generated stimuli as "cats" and "dogs." They found neural correlates of these categories in the lateral

prefrontal cortex, a brain region associated with the highest levels of cognitive function. The ability to abstract principles or rules from experience allows behavior to extend beyond specific circumstances that have been directly experienced. The most prevalent neuronal activity observed in the prefrontal cortex reflected the coding of the abstract 'match' and 'nonmatch' rules.

Tomaso Poggio's lab studies the problem of learning, as the gateway to the problem of intelligence both in brains and machines, focusing on three main directions: theory; engineering applications; and neuroscience. Their engineering applications include bioinformatics (diagnostic of human cancers from gene expression data), information extraction from text and the web, financial markets, trainable man-machines interfaces and computer vision for object detection. In the neurosciences, they have described a theory of visual cortex underlying object recognition and object categorization.

Molly Potter's lab has studied: short-term memory for naturalistic pictures, showing that the immediate representation is of gist, not just visual features; competition for attention between two near-simultaneous written words, showing intense competition over SOAs of at least 500 ms; and interaction between pictured objects and words in rapidly presented sequences.

Sebastian Seung's lab developed a new theory of hybrid analog-digital computation in the brain and about how the brains circuitry calculates in a manner that is a hybrid of analog and digital. They are developing this further in an application for object recognition.

Through fMRI, Anthony Wagner's lab examines how human memory is organized and supported by the mind and brain by exploring the cognitive control of memory. Recent advances include demonstration that frontal lobe short-term memory processes contribute to long-term memory formation; characterization of frontal lobe processes that guide semantic memory retrieval; and specification of the neural computations that accompany the unique state of memory failure known as the tip-of-the-tongue phenomenon. They recently initiated efforts to examine how age-related changes in frontal lobe circuits contribute to memory decline in the elderly.

By studying the interactions between brain areas using simultaneous neural recording techniques, Matthew Wilson's lab is pursuing the flow of mnemonic information during awake and sleep states between brain areas involved in memory formation and areas involved in higher-level cognition and decision making. They have recently found direct evidence of dreaming in rodents by identifying the reactivation during REM sleep of memory patterns established during recent awake experience—the first demonstration of a neural correlate of dreaming.

Brain Development And Plasticity

Guosong Liu's lab studied the functional maturation of glutamatergic synapses, a critical process during the formation of functional neural networks. In contrast to the prevailing hypothesis that silent synapses lack functional AMPA receptors, they found that these synapses contain functional AMPA receptors, but cannot release transmitters from presynaptic terminals properly. These results suggest new directions for identifying the locus of synaptic plasticity.

Elly Nedivi's lab has developed a highly sensitive subtractive cloning and differential screening method that has allowed them to identify and isolate a large pool of genes involved in neuronal plasticity. These 377 candidate plasticity-related genes (cpgs) constitute the basis of their studies. One of the cpgs that is currently under full scale investigation in the lab is cpg2. They found that cpg2 is a structural protein and because of its similarity to members of the spectrin/dystrophin protein family, it is possible that it also functions to regulate attachment or localization of synaptic components to the membrane and/or cytoskeleton.

Amnesiac is a fly mutant that William Quinn's lab isolated many years ago because the mutation shortens memory. The amnesiac gene encodes one or more peptide neurotransmitters. This year, they found that the peptides are concentrated in two cells in the fly (Drosophila) brain, and that neurotransmission from these two cells is necessary and sufficient for normal memory in the fly.

Mriganka Sur's laboratory demonstrated several basic mechanisms of plasticity in the developing and adult brain. In developing animals, his laboratory showed that mice lacking genes for ephrins A2 and A5 exhibit pronounced plasticity of retinal projections directed to the auditory thalamus. The ephrins act as barriers that normally prevent such plasticity. In adult animals, his lab showed that visual cortex neurons exhibit much greater plasticity of orientation tuning at pinwheel centers rather than at orientation domains. Visual cortex in alert monkeys also exhibited orientation plasticity based on features of stimuli, and such plasticity would serve to enhance the discrimination of orientations during natural viewing of scenes.

Richard Wurtman has been using weight loss treatment strategies based on discoveries in his lab involving the ability of certain dietary carbohydrates to increase brain serotonin, thereby both decreasing the appetite and diminishing depressive symptoms. He is also studying the ability of this program to block the massive weight gain observed in many patients taking drugs for schizophrenia, bipolar depression, and epilepsy.

Language and Number Systems Of The Brain
Edward Gibson's lab has shown that that connecting two words in a sentence is affected by the complexity of the inferences that are needed in the intervening material; and also discovered that intonational boundaries (e.g., pauses) are more likely to be placed at points of long integrations, and before complex constituents.

Steven Pinker has begun using fMRI to study the differences between regular and irregular inflection, and their implications for the interaction between memory and computation in language.

Elizabeth Spelke has been on sabbatical in the lab of Stanislas Dehaene in France doing behavioral and neuroimaging studies of representations of number in human adults and infants.

Kenneth Wexler's lab continued researching language development. They have shown that the important early linguistic stage that Wexler discovered covered a wide variety of other processes, including word order problems in Korean negation. They also continued developing an innovative new standard test for detecting children with Specific Language Impairment.

PERSONNEL CHANGES AND NEW PROGRAMS

Matthew Wilson was granted tenure, Nancy Kanwisher was promoted to full Professor, Guosong Liu was promoted to Associate Professor without tenure, and Earl Miller was appointed Associate Director of the Center for Learning and Memory. In addition, Morgan Sheng joined the faculty as the Menicon Professor of Neuroscience; Yasunori Hayashi is a new Assistant Professor in the Riken/MIT Neuroscience Research Center, and Lera Boroditsky is a newly hired Assistant Professor of Cognitive Science. The weekly colloquium series, begun last year, has enjoyed enormous success, as have the two Hans-Lukas Memorial lectures, the Margaret Roche Donlan Bidwell lecture and the social event at the annual Society for Neuroscience Meeting.

EDUCATION

Twenty graduate students entered in fall 2000, one with an NDSEG Fellowship, one with an NSF Fellowship, one with a Lee Kuan Yew Fellowship (Singapore), one with an NSERC Fellowship (Canada). Three of the new incoming students were funded by Rosenblith Fellowships (supported by a generous grant from Walter A. Rosenblith), and the rest were supported by department NIH training grants or other funds.

During this year, two students graduated with a Master of Science degree, and five graduated with the Ph.D. All five of the latter assumed postdoctoral positions in universities or research institutions (Department of Brain and Cognitive Sciences at MIT, Visual Sciences Laboratory of the Psychology Department at Harvard, Neuroscience Statistics Research Laboratory at MGH and in the Division of Applied Science and Engineering at Harvard).

The department had a total of 97 undergraduates this year, with 29 graduating seniors. A record number of 43 freshmen joined the department as new majors at the end of the 2001 spring term.

The newly revised undergraduate curriculum, described in last year's President's Report, was approved by the Committee on Curricula and will be implemented in AY2002. This will provide a streamlined approach to the major, making it simpler for students to complete the requirements while gaining a broad knowledge of the brain and cognitive sciences.

FACULTY HONORS AND AWARDS

Emilio Bizzi was invited to serve on the Board of Scientific Directors, Institute for Scientific Information in Turin, Italy. He was also invited to serve on the International Scientific Valuation Committee of the International Institute for Advanced Studies (SISSA) in Trieste, Italy.

Ann Graybiel received the Outstanding Women in Neuroscience Award from Brown University.

Yasunori Hayashi received an Ellison Medical Foundation New Scholar in Aging award.

Earl Miller received the Young Investigator Award, Society for Neuroscience, 2000.

Elizabeth Spelke received the Ipsen Prize in Neuronal Plasticity, 2001 (shared with A. Galaburda and J. Morton) and America's Best in Science and Medicine, Time Magazine (one of 20 selected - issue to appear in early August).

Anthony Wagner received the McKnight Scholar Award, 2001–2003, and the Paul E. Newton Career Development Professorship in Neuroscience, 2000–2003.

Mriganka Sur received the Sigma Xi Distinguished Lecturer, 2001–2003.

More information about the Department of Brain and Cognitive Sciences can be found online at http://web-bcs.mit.edu/.

Mriganka Sur

DEPARTMENT OF CHEMISTRY

In the 2000–2001 academic year, the Chemistry Department continued its strong programs in research and undergraduate and graduate education. Associated with the department currently are 257 graduate students, 120 postdoctoral researchers, and 64 undergraduate chemistry majors.

As of July 1, 2001, the Chemistry Department Faculty will comprise full-time faculty members including 6 Assistant, 3 Associate, and 21 Full Professors including one Institute Professor and three TBA slots. Joseph Sadighi will join the Department as an Assistant Professor on July 1, 2001. In December 2000, Professor Robert J. Silbey was named Dean of the School of Science.

FACULTY AWARDS AND HONORS

Professor Moungi G. Bawendi received the Wilson Prize, Harvard University Chemistry Department (2000), and the Sackler Prize, Administered by Tel Aviv University, (2001).

Professor Klaus Biemann received the 2001 ACS Award in Analytical Chemistry sponsored by Fisher Scientific Co.

Professor Stephen L. Buchwald was elected to the American Academy of Arts and Sciences

Professor Jianshu Cao received the NSF Faculty Early Career Development Award.

Professor Christopher C. Cummins was named a "Discover 20" Scientist by Discover Magazine.

Professor Catherine L. Drennan received the Surdna Foundation Research Award, and the Cecil and Ida Green Career Development Chair.

Professor Robert W. Field was named Haslam and Dewey Professor of Chemistry.

Professor Gregory C. Fu received the 2001 Springer Award in Organometallic Chemistry.

Professor Barbara Imperiali was elected to the American Academy of Arts and Sciences.

Professor Timothy F. Jamison received the 3M Innovation Award, and the 2001 Synthesis-Synlett Journals Award.

Professor Alexander M. Klibanov received the Merck Distinguished Lectureship, Rutgers University, and a Citation for one of the 20 top papers published in *the Biotechnology and Bioengineering Journal* over the last forty years. He also was elected a Corresponding Fellow of the Royal Society of Edinburgh.

Professor Stephen J. Lippard was named a Baker Lecturer, Cornell University, and received an Honorary D.Sc. Degree from Haverford College.

Professor Mario J. Molina received an Honorary Degree (Doctor Honoris Causa) from Pontifica Universidad Catolica del Peru and honorary degrees from the Universidad Nacional Mayor de San Marcos in Peru, Universidad de las Americas (Puebla, Mexico), Trinity College, and University of Miami. He also was elected a member of the Pontifical Academy of Sciences in the Vatican.

Professor Peter Seeberger received the CaP CURE Research Award, and was selected by the MIT Sigma XI Chapter to give the 2001 Sigma XI Lecture.

Professor Richard Schrock received the ACS Cope Scholar Award.

Professor Dietmar Seyferth was elected to U.S. National Academy of Sciences.

Professor Timothy M. Swager received the ACS Arthur C. Cope Scholar Award and the Vladimir Karapetoff Award.

Professor Harald J. Schwalbe received the Hoechst FoundationKarl-Winnacker Award, the Deutsche Forschungsgemeinschaft Gerhard-Hess Prize, and the Alfred P. Sloan Research Fellowship. He was named a Pew Scholar for Biomedical Sciences.

Professor Jeffrey I. Steinfeld was named Chair of the American Chemical Society's Committee on Environmental Improvement.

Professor Andrei Tokmakoff received the 2000 Packard Fellowship.

Professor Gerald N. Wogan was appointed as Princess Takamatsu Cancer Research Fund Lecture and received the Merit Award for Research Excellence that accompanies the Lectureship.

INFRASTRUCTURE DEVELOPMENTS

Phase III renovations for the Schrock and Cummins groups on the third and fourth floors of Building 6 were completed in September 2000. In keeping with the requirement to enhance safety of the researchers the renovated spaces feature student desk areas that are isolated from the laboratories. The scope of work included the installation of new fume hoods, casework, and epoxy flooring. Local chillers were installed in the new labs to supply chilled fluid to the fume hoods and island benches. The new mechanical systems in the labs and desk areas include specialty exhausts for chemical and flammable storage cabinets and vacuum pumps.

The Schrock group moved back from swing space on the first floor of Building 18, clearing the way for the Danheiser Group to occupy the space during Phase One of the Building 18 renovation project. The Danheiser group moved into the space in late November 2000. The Cummins group moved back from swing space in the former Seyferth labs on the second and third floors of Building 2, allowing this space to be used by Professor Jamison. The Jamison group will use the area as swing space during the Phases Two and Three of Building 18 project. The Jamison group moved into this space in December. This move marked the official start of Phase one of the Building 18 project. The space on the third floor of Building 2 was outfitted to serve as temporary space for Professor Sadighi who arrived July 1.

The comprehensive renovation program for Building 18 is underway. Construction of the mock-up lab was completed in September. The mock-up lab was used to finalize the design of the labs and student areas. The project began officially with the shutdown of mechanical shaft number 1 in December 2000. The faculty remaining in the south end offices in Building 18 are expected to move to the temporary faculty offices later this summer or fall. The new labs and desk areas will begin to be occupied in sequence of events termed stratified phasing. This process consists of vacating a space, completing the construction at the phase boundaries followed by a group into space. This process will allow for construction of areas at construction boundaries to be completed with the least disruption to the researchers. Most of the mechanical systems in Building 18 also have been renovated in 2001. This includes the electrical substation, air handling units, chilled water system and other mechanical systems. Phase Two is scheduled to begin in the fall of 2001 and Phase Three in summer of 2002.

EDUCATION

In the fall of 2000, 65 students entered the graduate program of the Chemistry Department and from September 2000 through June 2001 the department awarded 40 Ph.D. degrees. The number of graduate students in our program is expected to continue to increase over the next few years as we rebuild the faculty to its normal level. In fall 2000 two new general chemistry subjects were introduced to replace Chemistry 5.11. Chemistry 5.111 ("Principles of Chemical Science") covers essentially the same range of topics as the former course, while the second course, 5.112, is faster paced and is intended for students with an unusually strong background in chemistry. A new biological chemistry restricted elective subject for chemistry majors, Chemistry 5.08, was introduced in the spring and presented by Professors Stern and Stubbe. In the area of graduate chemistry education, a number of changes in the system for advising and supervising graduate students went into effect this academic year. The aims of these changes include improving communication between students and faculty, reducing stress and ensuring that every student develops substantive relationships with faculty members besides their research supervisor. At the Senior Recognition Dinner in May, the recipients of the 2001 Undergraduate Chemistry Awards were announced:

- The Alpha Chi Sigma Award (for achievement in research, scholarship and service to the department)—Theodor Agapie
- American Institute of Chemists Foundation Award (in recognition of outstanding achievement, ability, leadership and character)—Susan Yuditskaya
- The Merck Index Award (for outstanding scholarship)—Marie Blanke, Ian Chan, and Adrianne Stebbins
- The MIT Chemistry Research Award (for outstanding research in the field of chemistry)—Christopher Snow and Susan Yuditskaya
- Hypercube Scholar (for outstanding achievement in the area of computational chemistry)—Christopher Snow
- The Frederick D. Greene Teaching Award (for outstanding contributions in the area of teaching)—Daniel O'Connell
- MIT Chemistry Service Award (for significant contributions in the area of service to the department)—Yevgeniya Nusinovich

RESEARCH HIGHLIGHTS

Professor Moungi G. Bawendi's group, collaborating with Prof. Smith (EECS), demonstrated lasing using nanocrystal quantum dots coupled to a microcavity.

Rick Danheiser's group reported an efficient total synthesis of ascochlorin based on a convergent "benzannulation strategy" previously developed in their laboratory. Ascochlorin and related compounds have attracted attention as potential drugs for the treatment of hyperlipidemia, diabetes, and cancer.

Catherine L. Drennan's laboratory determined the first X-ray structure of a ribonucleotide reductase that requires coenzyme B12 for the conversion of ribonucleotides to deoxyribonucleotides, the rate-limiting step in DNA biosynthesis.

John Essigmann's group has prepared a compound that consists of a DNA damaging nitrogen mustard linked to a ligand for the estrogen receptor. It shows selective toxicity for cancer cells that express the estrogen receptor and good bioavailability in tumor bearing animals.

Robert Field's research group has demonstrated new experimental and statistical pattern recognition techniques to characterize mechanisms of Intersystem Crossing in small polyatomic molecules. The experimental method exploits a pattern recognition technique in a first exploitation of "meta-patterns" (patterns of patterns) which has enabled measurement of the coupling strength between "bright state" and "doorway state" *en route* to the dense manifold of "dark states."

Gregory C. Fu's group has developed the first effective non-enzymatic acylation catalyst for the kinetic resolution of amines. Such a process could have utility in the synthesis of pharmaceutical compounds.

In Robert G. Griffin lab high resolution solid state NMR techniques for determining the structure of peptides and proteins have matured to the point that they have completed their initial structure of molecule with an unknown structure.

Alexnder M. Klibanov's group has created polymeric surface coatings that kill airborne bacteria on contact. This methodology may prove generally useful in coating various consumer and medical products to make their surfaces antibacterial.

Stephen J. Lippard's group achieved the first hydrocarbon oxidation chemistry from a well defined methane monooxygenase model compound using air as the oxidant. They also imaged zinc in brain slices with a powerful fluorescent sensor.

Professor Keith A. Nelson developed methods for using large numbers of ultrashort light pulses that arrive at many specified sample locations and times for the generation, imaging, and control of coherent lattice waves that move at light-like speeds through crystalline solids.

The Daniel G. Nocera group achieved for the first time a photocatalytic HX-splitting cycle, driven at the molecular level. They used a two-electron mixed-valence dirhodium compound to photocatalyze the reduction of hydrohalic acid to hydrogen.

Richard R. Schrock's group accomplished a dramatic expansion of the use of enantiomerically pure molybdenum alkylidene complexes for enantioselective olefin metathesis reactions and developed new catalysts for "perfect" living polymerization of ordinary olefins.

Peter H. Seeberger's laboratory developed an automated oligosaccharide synthesizer that allows for the solid-phase assembly of biologically important carbohydrates. This technique has been used to make discoveries in the areas of tropical diseases, cancer vaccines and basic immunology.

Robert J. Silbey's group has theoretically analyzed the single molecule spectra of the light harvesting complex (LH2) consisting of 18 chlorophyl molecules and showed the importance of disorder in understanding the spectrum.

Timothy M. Swager's group developed a fundamental new paradigm for the organization of solutes in polymers and liquid crystals based on the minimization of free volume. This method is general and has the potential to produce higher performance displays, stronger materials, and novel mechanical properties.

Andrei Tokmakoff's group demonstrated the use of two-dimensional infrared spectroscopy, an optical analog of the methods used in magnetic resonance, as a method for capturing transient molecular structure in solution with a picosecond shutter speed.

More information about the Department of Chemistry can be found online at http://web.mit.edu/chemistry/www/.

Stephen J. Lippard

DEPARTMENT OF EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

The Department of Earth, Atmospheric, and Planetary Sciences (EAPS) has broad intellectual horizons that encompass the solid earth, its fluid envelopes, and its diverse neighbors throughout the solar system and beyond. We seek to understand the fundamental processes defining the origin, evolution and current state of these systems and to use this understanding to predict future states. The department comprises 37 faculty, including two with primary appointments in Civil and Environmental Engineering, 195 graduate and undergraduate students, and over 100 research staff, postdoctoral appointments and visiting scholars. EAPS is notable for its collaborations with other MIT Departments and Schools to address complex interdisciplinary problems. In this vein, the Department is an enthusiastic supporter of the new Earth Systems Initiative. On a sad note, Professor John Marmion Edmond FRS passed away suddenly during the spring and will be missed by all.

EDUCATIONAL ACTIVITIES

EAPS has vigorous graduate educational programs in geology and geochemistry, geophysics, atmospheres, oceans, climate, and planetary science. Each disciplinary area of EAPS continues to be ranked among the top graduate programs in the country, with most areas being rated either first or second nationally. The EAPS graduate program currently focuses on the Ph.D. degree, which is the goal of about 90 percent of its graduate students. During the past academic year, 161 graduate students were registered in the department including EAPS students in the MIT/Woods Hole Oceanographic Institution (WHOI) Joint Program. Of these 119 are U.S. citizens and 42 are international students. Women constitute 42 percent of the graduate student population. Fifteen Ph.D. and 14 S.M. degrees were awarded during the past academic year.

The new EAPS Master's Degree Program in Geosystems graduated its fourth class this year. The program's novel curriculum is designed to educate geoscientists in system-level analysis and prepare them for professional careers in high-technology industries concerned with complex geosystems. All three of the 2000–2001 entering students successfully completed the course work in two semesters. Another relatively new degree program is administered by the department's Program in Atmospheres, Oceans and Climate (PAOC). This new Ph.D. in Climate Physics and Chemistry has 11 students currently enrolled.

A biannual prize has been developed to recognize and reward the efforts of outstanding EAPS Graduate Teaching Assistants. Winners during the past year include Matthew Reuer, Janet Wu, Bridget Bergquist, and Philip Tracadas.

EAPS continues to maintain a strong presence within the undergraduate program at MIT. It offers a wide variety of Freshman Advising Seminars each fall with about 10 faculty members participating each of the past three years. A new undergraduate seminar has been developed to introduce newly declared sophomore majors to the broad research interests of the faculty. This seminar was very well received during its inception and is now being modified and expanded to include one-on-one mentoring by faculty members in the areas of technical writing and oral communication. This year EAPS gained 14 new majors which is a very significant increase above the previous year (five new majors). Professor Kip Hodges developed and launched a new freshman-level educational experience (12.000 "Solving Complex Problems") with support from the d'Arbeloff Fund for Educational Excellence. A multidiciplinary learning collaboration involving freshmen, upperclassmen, graduate students, and alumni, the inaugural offering of the subject won very positive reviews from its participants.

The EAPS Independent Activities Program (IAP) continues to be one of the most vibrant at MIT, and faculty have maintained a healthy Undergraduate Research Opportunities Program (UROP). Opportunities for IAP field experience included trips to the world's largest geothermal field and the wind farms in California, the Lowell Observatory in Flagstaff, Arizona, the NASA Goddard Space Flight Center in Maryland, and a geoscience field camp in Nevada.

The Bachelor of Science curriculum was reorganized several years ago to include three areas of concentration: geoscience, physics of atmospheres and oceans, and planetary science and astronomy. Each concentration encompasses a set of required courses, a sequence of field and laboratory subjects, and independent study or thesis preparation. Historically, students have primarily chosen to specialize in either geoscience or planetary science and astronomy. In the past three years however, there have been an increasing number of students (five to six) pursuing

studies in the physics of atmospheres and oceans. Within this concentration area, a popular new Institute Laboratory course has been developed by Professor Marshall and Dr. Illari that permits undergraduates to develop and perform experiments related to the general circulation of the atmosphere and the day-to-day sequencing of weather events. EAPS undergraduate enrollment comprised 34 majors and 15 minors during 2000–2001.

FACULTY

Professor Rafael Bras has been elected to the National Academy of Engineering.

Professor Clark Burchfiel has been nominated unopposed for Vice President, then President, of the Geological Society of America.

Professor Kerry Emanuel was elected to give the honorific Charney Lecture at the 2001 American Geophysical Union Spring Meeting.

Professor Brad Hager was selected for the 2001 George P. Woollard Award of the Geological Society of America. The Woollard Award is given annually to an individual who has contributed in an outstanding manner to geology through the application of the principles and techniques of geophysics.

Professor Julian Sachs was awarded the Henry L. and Grace Doherty career development professorship in ocean utilization to support work on paleothermometry in oceanic sediments to determine abrupt climate change mechanisms.

Professor Peter Stone was elected a Fellow of the American Association for the Advancement of Science.

Professor Jack Wisdom has been given the 2002 Dirk Brouwer Award by the Division of Dynamical Astronomy of the American Astronomical Society "for his fundamental contributions and leadership in the field."

Professor Maria Zuber was elected a Fellow of the American Geophysical Union and has received the NASA Group Achievement Awards for the Mars Global Surveyor Mission, Mars '98, and the Mars Mission Failure Investigation Board.

Over the past year several vigorous searches have led to four exciting new faculty appointments. Roger Summons, whose work in "molecular fossils" is widely recognized and lauded, has been appointed Professor of Geobiology. Julian Sachs, an accomplished young paleoclimatologist, has joined the faculty as the Doherty Assistant Professor. David Mohrig, who has made notable contributions to sedimentary geomorphology, was named Assistant Professor of Geology. Most recently, James Hansen, who is doing innovative research on optimal observing and forecasting has joined us as Assistant Professor of Atmospheric Science.

The department currently has active faculty searches in six exciting areas. The first is in Planetary Science which is making dramatic advances toward understanding the formation and evolution of our solar system and other planetary systems. The second faculty search is for another faculty member in Geobiology. We envision this emerging new field to encompass research that includes the origin of life, evolutionary and developmental biology, microbial biology, and the interactions between ecosystems and climate.. The time is right for the expansion of the department into this exciting new field which is directly relevant to the proposed Earth Systems Initiative. The third faculty search is in Oceanic and Climate Sciences. We aim to enhance our existing programs in oceanography and climate research including ongoing work in the Center for Global Change Science's Climate Modeling Initiative.

The fourth faculty search is in Experimental Geophysics and Geochemistry. We are seeking an outstanding scientist in the area of experimental geophysics and geochemistry who studies the physics and chemistry of Earth materials. The fifth faculty search is in Seismology. This area, which provides fundamental information on the structure and dynamics of the earth, is entering an exciting new era incorporating new measurement networks. The sixth and newest search is in Atmospheric Chemistry. The current coupled challenges of air pollution and climate have increased the demand for new knowledge of chemical processes.

The department continues to pioneer work in new interdisciplinary areas. The Earth Resources Laboratory is broadening its base to include a wider range of geophysical, geological, and environmental topics. The Center for

Global Change Science (including the Climate Modeling Initiative) and the Program in Atmospheric, Oceans and Climate continue to foster cross-fertilization among all areas of the earth sciences that control the climate system. Research activities are gradually broadening so that geologists are now working with oceanographers and atmospheric scientists, and models of the climate system have been constructed both for the modern system and for times deep in the geological past. A large new faculty group interested in co-evolution of the geosphere and biosphere has formed and is participating in the definition of the new earth systems initiative. Department faculty also continue to play leading roles in the MIT Joint Program on the Science and Policy of Global Change.

CURRENT RESEARCH

Professor Edward Boyle's group has shown for the first time that a large fraction of oceanic iron, an element that is essential to marine life but is in short supply, occurs as colloids less than 0.2 micrometers in diameter; this work has implications to the bioavailability of iron. His group has also obtained data from five sites in the North Atlantic and North Pacific ocean which demonstrate that during the past two decades lead (Pb) has decreased in the upper two kilometers in the ocean as a result of the phasing out of leaded gasoline.

Professor Clark Burchfiel's nine year program to monitor crustal movements in eastern Tibet and South China has been completed. The crustal velocity map shows velocities from India to Eurasia are locally absorbed within the Tibet plateau region, but relative to a fixed Eurasia there appears to be an eastward movement of eastern Tibet coupled with eastern China beyond the plateau. This result is different from nearly all existing tectonic models for this region.

Professor Jim Elliot, student Susan Kern, and their colleagues at Lowell Observatory have discovered over one hundred and twenty Kuiper Belt objects in the course of their Deep Ecliptic Survey, which being carried out at Cerro Tololo and Kitt Peak National Observatories. Follow-up observations of one of the objects (2001 KX76) with MIT's MagIC camera on Magellan—in collaboration with Dr. David Osip—shows that it may be the largest Kuiper Belt object presently known. Work is continuing to characterize the physical properties of these bodies, which lie beyond the orbit of Neptune.

Professor Frederick Frey is obtaining an understanding of the Kerguelen Plateau, a very large submarine province in the south Indian Ocean, by geochemical studies of lavas cored during an Ocean Drilling Program expedition. Although this plateau formed after breakup of Australia, India and Antarctica, it is evident that the mantle-derived magmas were affected by microcontinental fragments that became isolated in the newly formed Indian Ocean Basin.

Professor Kerry Emanuel's recent research has focused on a theory for multiple stable climate regimes, which has the potential to explain a number of enigmatic features of the earth's climate, including sensitivity to orbital variations, sudden transitions, and polar warmth during such periods as the early Eocene and late Cretaceous.

Professor Tim Grove and his colleagues have carried out experiments in their MIT laboratory that reproduce the earliest crystallizing minerals in the Shergotty meteorite; one of 15 Meteorites believed to have come from Mars. They have determined that the Shergotty magma contained ~ 2 wt. percent water prior to eruption on the Martian surface. This result points to volcanic recycling as a possible mechanism for getting water to Mars's surface.

Professor Brad Hager and his group developed a procedure to estimate more reliably slip rates and locking depths of fault systems using geodetic data, with applications in California, Turkey, and the Tien Shan Mountains of Central Asia. In California and the Tien Shan, there is excellent agreement with slip rates inferred independently from geologic studies. In the region near Istanbul, Turkey, their results suggest that the most likely maximum earthquake moment release is a factor of two smaller than previously believed.

Professor Kip Hodges' activities over the past year have focussed on the development of a new laboratory for (U-Th)/He geochronology, a technique especially well-suited for exploring the evolution of topography in modern mountain systems. At the same time, he has continued tectonics research in the Nepalese Himalaya.

Professor Richard Lindzen is studying climate feedbacks, in cooperation with colleagues at NASA's Goddard Space Flight Center. They are attempting to combine various satellites in order to get adequate spatial, temporal and spectral resolution. Climate sensitivity is being looked at by examining the time response of surface temperature to

changes in atmospheric regime. Rapid response is associated with low sensitivity. Also, in cooperation with a student, Pablo Zurita, they are studying how the eddies that transport heat equilibrate nonlinearly.

Professor John Marshall continues his research into the role of the ocean in climate variability. His group has been investigating possible patterns of ocean circulation and biogeochemistry in warm periods in earth history, such as the Cretaceous and the Permian. With Professor Alan Plumb, he has been preparing an undergraduate text book in atmosphere and ocean dynamics.

Professor Reginald Newell and colleagues John Cho and Erik Lindborg have studied variations in the lower stratosphere of temperature and ozone using aircraft data to distinguish the direction of energy and scalar variance flux between the scales of motion. In related work, a layer of high potential vorticity from the stratosphere was observed to trap below a pollution plume rising from the boundary layer and the mechanics were studied.

Professor Ronald Prinn and Colleagues have been studying long-term variations of the hydroxyl radical (OH) which is the dominant oxidizing chemical in the atmosphere. Global measurements of 1,1,1-trichloroethane provide an accurate method for determining the global and hemispheric behavior of OH. Analysis of these measurements shows that global OH levels were growing between 1978 and 1988, but the growth rate was decreasing so that OH levels began declining after 1988. These variations imply important and unexpected gaps in current understanding.

Professor Paola Rizzoli and her collaborators have focussed on three major research issues. 1) Model-data synthesis in the Atlantic ocean to understand tropical/subtropical interactions using TOPEX and WOCE datasets in collaboration with Dr. Bussalacchi and his group at the Goddard Space Flight Center. 2) Predictability of geophysical fluid flows under a program of the Office of Naval Research which she co-directs. 3) Physical and biochemical modeling of marginal seas, with a focus on the Mediterranean and Black seas.

Professor Daniel Rothman has developed a new model for the evolution of atmospheric carbon dioxide levels for the last 500 million years. The model, which is based on the reconciliation of geochemical signals related to tectonic and biological activity, shows no systematic coupling of atmospheric carbon dioxide levels to climate at tectonic time scales.

Professor Julian Sachs deduces past sea surface temperatures from ocean sediments. Whereas records from Antarctic ice cores indicate a long term cooling into the Last Glacial Maximum (~21,000 yr ago), surface temperatures from the southeast Atlantic warmed substantially 41,000-25,000 yr ago, suggesting a strong response to changes in Earth's tilt. Evidence for 20th-century warming was observed in sediments from the Nova Scotian Margin, and a pronounced cooling inferred early in our present interglacial period in the subpolar NW Atlantic.

Professor Stone and his collaborators in the MIT Joint Program on the Science and Policy of Global Change have used multiple climate diagnostics and their optimal fingerprint detection algorithm to investigate how strong the global forcing due to anthropogenic aerosols has been over the last 50 years. They find that the 95 percent confidence interval for the forcing (cooling) is -0.3 to -1.0 W/m^2, a much smaller range of uncertainty than that quoted by the Intergovernmental Panel on Climate Change in their recent assessment.

Professor Nafi Toksöz has been working on seismological techniques and fostering international cooperation for reducing earthquake risk to major population centers.

Professor Rob Van der Hilst and his group have studied the structure and evolution of Earth's deep mantle, using high resolution imaging and last year they produced the best global model for compressional wavespeed available to date. They have also begun to constrain the nature of compositional heterogeneity of the deep mantle (depth > 2000 km), but despite extensive searches evidence for sharp interfaces has not been found. The investigation of the Australian continent has shifted to determining and understanding its mechanical and seismological anisotropy.

Professor Kelin Whipple has worked on: relationships between climate, tectonic setting, rock type, and elevation and relief of mountain belts; controls on timescales of mountain building and decay; and the nature of the sediment supply delivered on-shore and off-shore during an orogenic cycle. Minimum estimates of landscape response time argue against the often-invoked steady-state assumption, the role of sediment flux in modulating river incision rates was analysed, and a river incision law was refined to predict patterns and rates of tectonic uplift.

Professor Wisdom, with Professor Gerald Sussman in EECS, has published a novel book on classical mechanics, which is used in a course. With Professor Jihad Touma (AUB), Professor Wisdom has studied the evolution of Earth and Venus through nonlinear core-mantle resonances. These are resonances between the precession of the fluid core and the motion of the planet around the Sun. They speculate that heating during resonance passage may have led to the global resurfacing of Venus that occurred 700-800 million years ago.

Professor Carl Wunsch and many of his associates continue to exploit recent global scale oceanographic data sets, combined with numerical models of the ocean, to estimate the time-varying absolute ocean circulation. The results are important for understanding of the way in which the ocean controls climate change.

Professor Maria Zuber and colleagues used their laser altimeter on the Mars Global Surveyor spacecraft to constrain the timing of formation of the massive Tharsis volcanic on Mars. The associated release of volatiles early in Martian history can explain the thicker atmosphere and extensive surface water that marked an earlier, clement climate on Mars. Zuber and colleagues also used their laser altimeter on the Near Earth Asteroid Rendezvous mission to produce the first high resolution model of the shape and internal structure of an asteroid.

More information about this department can be found online at http://www-eaps.mit.edu/.

Ronald G. Prinn

DEPARTMENT OF MATHEMATICS

The Department of Mathematics at MIT seeks to improve upon its top ranking in both research and teaching by aggressively hiring the very best faculty, with special attention to the recruitment of top women and under-represented minority candidates, and by continuing to serve the broad and varied educational needs of its graduate students, the mathematics majors, and all undergraduates of the Institute.

STUDENTS

During the academic year 2000–2001, there were 273 undergraduates majoring in mathematics, 230 in Course XVIII, Mathematics, and 43 in Course XVIII-C, Mathematics/Computer Science. Bachelor of Science degrees, including double majors, were awarded to 93 students, 79 in Course XVIII and 14 in Course XVIII–C. There were a total of 109 graduate students in mathematics, all in the Ph.D. program. This year 15 students received the doctoral degree.

FACULTY CHANGES

The Mathematics Department experienced the death of two senior faculty members this year: Professor Franklin Paul Peterson and Professor Emeritus Dirk Struik. Professor Peterson joined the MIT faculty in 1958 and was an internationally respected algebraic topologist specialized in the study of cohomology operations. He chaired the Pure Mathematics Committee during the periods 1972–75, 1979–82, and 1984–87, and served as Treasurer of the American Mathematical Society from 1974–1998. Professor Emeritus Dirk Struik was a member of the MIT faculty from 1928–1960, a highly respected analyst and geometer and an internationally acclaimed historian of Mathematics, beginning with his book, *Concise History of Mathematics*, in 1948. Professor Struik maintained a life-long interest in social justice and Marxist Socialism; which, during the McCarthy period in 1951, led to an indictment "to overthrow the governments of the United States and Massachusetts." The indictment was dropped five years later, during which period Professor Struik was on paid-leave from MIT; he was reinstated to the faculty by President James R. Killian, Jr. in 1956.

Assistant Professors Pavel Etingof (representation theory, quantum groups) and Lars Hesselholt (algebraic topology) were promoted to Associate Professor (Professor Etingof with tenure). Dr. Alexander Postnikov will join the department as Assistant Professor of Applied Mathematics. Specialized in algebraic combinatorics, he is currently a Miller Research Fellow at the University of California, Berkeley.

Associate Professor Michael Brenner resigned from MIT for a faculty position at Harvard University, and Assistant Professor Karen Smith resigned for a faculty position at the University of Michigan.

Professor Michael Artin will continue as chair of the Undergraduate Committee, Professor Daniel Kleitman as chair the Applied Mathematics Committee, Professor Richard Melrose as chair of the Pure Mathematics Committee, Professor Tomasz Mrowka as Chair of the Graduate Student Committee, and Professor Michael Sipser as chair of the Committee of Advisors.

RESEARCH

Here are a few snippets from the great range of research underway in the department.

Sigurdur Helgason has proven a certain refinement of the Huygens Principle, and obtained a stronger form of the support theory for the Radon transform on a symmetric space G/K. With Alexey Rudakov, Victor Kac conjectured a new generation of quarks on the basis of representation theory of E(3,6).

Bonnie Berger, with Visiting Professor Lenore Cohen, MIT Professor Jonathan King, graduate student Philip Bradley, and undergraduate Matthew Menke, developed a mathematical method, codified in the BetaWrap program, which can predict in nanoseconds whether a protein folds into a structure called a beta helix.

Hubert Bray is generalizing his three-dimensional theorem on the mass of black holes to the case of higher dimensional black holes. David Ingerman is working on a new representation of matrices as Dirichlet-to-Neumann maps based on a theory of planar graphs and continued fractions, among other applied mathematical studies. Byunghan Kim, a mathematical logician, has begun to develop a "geometric simplicity theory," combining ideas

from his own simplicity theory with Rota's combinatorial geometry. Santosh Vempala has developed a simple new algorithm for solving linear and convex programs in polynomial time.

Nine MIT undergraduates participated with five mathematics graduate-student mentors in the department's fourth Summer Program in Undergraduate Research (SPUR), which offers a six-week program of full-time research experience culminating in written papers and lectures to faculty.

Summer 2000 was the eighth year of the Mathematics Department's participation in the Research Science Institute program (RSI) for gifted high school students, in which eleven mathematics graduate students mentored seventeen high school students from the U.S. and abroad for a five-week period.

HONORS, PRIZES AND AWARDS

Professor Michael Hopkins received the Oswald Veblen Prize in Geometry for his work on homotopy theory.

Professor Victor Kac was invited as Plenary Speaker at the International Congress of Mathematicians 2002.

Professor Thomson Leighton received the IEEE Babbage Award for outstanding research in parallel and distributed computing. *U.S. News and World Report* also named him one of ten Innovators of the Year.

Professor Richard Stanley received the Leroy P. Steele Prize for Mathematical Exposition of the American Mathematical Society for his two-volume work, *Enumerative Combinatorics.*

Associate Professor Alan Edelman (together with Olga Holtz, Erik Elmroth and Bo Kagstrom) received the Society for Industrial and Applied Mathematics (SIAM) Activity Group on Linear Algebra Prize for the most outstanding paper in English on applicable linear algebra. Professor Edelman was also awarded the SIAM Outstanding Paper Prize for a separate article.

Associate Professor Michel Goemans (together with David Williamson, Michele Conforti, Gerald Cornuejols, and M.R. Rao) received the eighth Delbert Ray Fulkerson Prize, awarded every three years for a paper in discrete mathematics.

Assistant Professor Sara Billey received a Presidential Early Career Award for Scientists and Engineers, established by President Clinton in 1996. She was also selected for the MIT Class of 1922 Career Development Professorship.

Assistant Professor Hubert Bray received an Alfred P. Sloan Research Fellowship.

Assistant Professor Lucia Caporaso was among the first recipients of the Medaglia di Le Scienze by Le Scienze.

CLE Moore Instructor Ravi Vakil was awarded the G de B Robinson Award of the Canadian Mathematical Society for an outstanding paper in the *Canadian Journal of Mathematics.*

Graduate students received several awards. The Housman Graduate Student Teaching Award was given to Federico Ardila and Donald Yau for their exceptional skill and dedication to teaching. Adam Klivans was awarded the Charles W. and Jennifer C. Johnson Prize for an outstanding research paper accepted in a major journal by a graduate student in mathematics. The Clay Mathematics Institute selected Philip Bradley, Edward Goldstein, and Jesper Grodal for its *Liftoff* postdoctoral research program for summer 2001.

Seniors Ethan G. Cotterill and Joshua Sussan were awarded the Jon A. Bucsela Prize in Mathematics in recognition of distinguished scholastic achievement. Among those seniors awarded degrees in mathematics, eight were elected to Phi Beta Kappa.

The MIT Mathematics team, comprised of Sophomore Ivan Petrakiev, Junior Abhinav Kumar, and Senior Aram Harrow, finished second in the 2000 William Lowell Putnam Intercollegiate Mathematical Competition. Abhinav Kumar and Sophomore Pavlo Pylyavskyy were among the five highest ranking individuals and was therefore designated Putnam Fellows. MIT had three other individual scores in the top twenty-five, and another ten individuals were given Honorable Mention for finishing in the top sixty. These included Junior Marketa Havlickova

who was the highest ranking of all female competitors. A total of 2800 students from 434 collages and universities in Canada and the US participated in the competition. MIT had the largest number of individuals (15) in the top 60.

EDUCATIONAL

Enrollments in the Mathematics Department's service courses have been steady. The number of mathematics majors in each class seem to be rising, having jumped from the 70s to the 90s two years ago. A total of 93 majors graduated in 2001, of which 50 took their first degree in mathematics. This year 63 sophomores chose to major in mathematics.

As is shown by the results of the last Putnam exam, in which 15 of the 60 students who received special recognition were MIT undergraduates, our top mathematics students seem to be doing better than ever. No doubt thanks are due in part to the excellent problem-solving seminar run by Professor Hartley Rogers and Richard Stanley.

The Mathematics Department was short of teaching staff during the year. There was a drop in available teaching hours in every faculty category, so the reasons for this are diffuse. But the shortage was substantial. It was met by increasing recitation size slightly and by using essentially all of our teaching assistants in the classroom. Other jobs for teaching assistants, such as grading papers, suffered accordingly. To continue this overuse of teaching assistants would seriously affect the department's undergraduate and graduate programs in the long run.

With the assistance of the d'Arbeloff Grant on a project developed by Professors David Jerison, Haynes Miller, and Gilbert Strang, the Mathematics Department is engaged in revising its service courses.

More information about the Mathematics Department can be found online at http://www-math.mit.edu/.

David A. Vogan, Jr.

DEPARTMENT OF PHYSICS

Physics faculty members continue to receive recognition by the outside community. Claude Canizares received two NASA Public Service Medals for Chandra and Service; Deepto Chakrabarty and Alexander van Oudenaarden received Alfred P. Sloan Research Fellowships; Bruno Coppi was Knighted Great Officer of the Order of Merit of the Republic of Italy; Mildred Dresselhaus received the National Materials Advancement Award of the Federation of Materials Societies, the Karl T. Compton Medal for Leadership in Physics of the American Institute of Physics and was elected Honorary Member of the Ioffe Institute, Russian Academy of Sciences; Alan Guth won the Robinson Prize in Cosmology of the University of Newcastle upon Tyne and the Benjamin Franklin Medal in Physics, Franklin Institute; Daniel Kleppner was awarded a Doctor of Philosophy (honora causa), Williams College; Ernest J. Moniz received Honorary Doctorates from the University of Athens, Greece and the University of Erlangen-Nurnberg, Germany, as well as the Seymour Cray HPCC Industry Recognition Award; Rainer Weiss was Elected to the National Academy of Sciences

Associate Professor Peter Fisher was promoted to Full Professor with tenure. Associate Professor Uwe-Jens Weise received tenure, Assistant Professor Krishna Rajagopal was promoted to Associate Professor with tenure, and Assistant Professor Fredric Rasio was promoted to Associate Professor. New faculty members in the department are Assistant Professors Scott Burles, Erotokritos Katsavounidis, Young Lee, Kate Scholberg, and Senthil Todadri.

EDUCATION

The department has made its reading room available as the first space for the "technology enabled active learning" (TEAL) experiment in freshman physics education. We will merge lecture, recitations, and hands-on laboratory experience into a technologically and collaboratively rich experience. A dozen or so students will gather at a round table, with ten or so tables in the large reading room space, for five hours per week. They will be exposed to a mixture of formal instruction, lab work with desktop experiments, and collaborative work in smaller groups of three or four, in a computer rich environment (one networked laptop per three students). The reading room will be temporarily housed on the third floor of Building 4 until a permanent location is prepared.

Our standard S.B. degree provides MIT students an unsurpassed preparation for graduate study in physics. However, many students, although strongly attracted to physics, have broader interests that will take them into different careers after graduation. We have, therefore, initiated a new degree that will provide students with an understanding of the fundamentals of physics and an appreciation of the physicist's approach to problem solving, while requiring a focus in some area that will support career options other than a Ph.D. in physics. The initiation of this degree has turned around the decline in the number of physics majors that we have experienced continuously for more than 30 years.

DIVERSITY

The Department of Physics is in the forefront in producing minority Ph.D.'s. To recruit new minority graduate students, the Department continues to support students' membership in the National Conference of Black Physics Students (NCBPS) and the National Society of Black Physicists (NSBP). The department created Physics Department Head Fellowships (equivalent to the Presidential Fellowships) that are targeted for North American under-represented candidates. We also commit to funding all travel expenses for under-represented North American candidates, as well as all North American female candidates. Despite these efforts, the pool of qualified minority candidates for graduate school remains extremely small, and the qualified students are aggressively recruited by the competition.

The same is true of women. While the fraction of women students is higher than for most institutions, it is still painfully small. We support the Women in Physics group, which consists of current female graduate students, by providing space and funding for bi-weekly dinners and other events. In addition, the group is active in recruiting female candidates to the program (i.e., they host a reception during Open House for female candidates and they telephone individual female candidates). This organization has received financial support from an alumna of our department.

The department continues to aggressively recruit and retain underrepresented minorities and women for faculty positions. This past year, the department recruited an outstanding female scientist, Kate Scholberg, an experimental elementary particle physicist.

PAPPALARDO FELLOWS IN PHYSICS

Neil Pappalardo has made possible a program in the department to recent Ph.D.'s of exceptional promise. One of the features that distinguishes the sciences in general, and physics in particular, is the importance of the accomplishments of outstanding individuals. The purpose of the Pappalardo Fellowships in Physics is to identify and support unusually talented young physicists, and to provide them with the opportunity to pursue research of their own choosing. The first three fellows arrived in September of 2000 and the second three will arrive in the fall. The Pappalardo Fellows have complete freedom in their choice of research and are matched with a mentor chosen on the basis of their research interests. Fellows meet for lunch once per week and for dinner once per month, along with the Executive Board, mentors, and their guests.

RESEARCH HIGHLIGHTS

Heavy Ion Collisions

When nuclei collide at relativistic velocities, a region of space is created with extremely high energy density. The higher the velocity of the colliding nuclei, the higher is the produced energy density. It is expected that at sufficiently high velocities a new state of matter will be created, the so-called Quark-Gluon Plasma (QGP), in which quarks and gluons are free and not confined, as they normally are in protons and neutrons. The QGP is the state in which the whole universe found itself, up to about ten microseconds after the big bang. Last summer the world's highest energy nuclear collider (RHIC) was commissioned at Brookhaven National Laboratory. MIT is leading "Phobos" a major research project designed to study the collisions produced at RHIC. The Phobos collaboration has had a very good year. The Phobos detector is performing better than expected, and, as a result, Phobos, rather than the other detectors, has obtained the first physics results from RHIC. These results have had a significant impact on the field. They show that a high energy density and high pressure region filled with quarks is created at RHIC. The energy density is lower than original expectations for RHIC but it should be high enough for the formation of the QGP. Detailed studies are on the way in search for direct evidence of the formation of the QGP and other new phenomena. Three faculty members are involved in Phobos, Wit Busza, Gunther Roland and Bolek Wyslouch. There are also seven graduate students, seven research staff and several UROP students. Studies with Phobos at RHIC will continue for at least the next three or four years. In five or six years a new energy frontier will be opened when the LHC collider is completed at CERN in Europe. The MIT group has already begun planning for probing the even higher energy densities that will become available at CERN.

Vortex Lattices In Bose-Einstein Condensate

When a quantum-mechanical particle moves in a circle the circumference of the orbit must be an integer multiple of the de Broglie wavelength. If one spins a normal liquid in a bucket, the fluid will rotate as a rigid body, in which the velocity smoothly increases from the center to the edge. However, for particles in a single quantum state such as a Bose-Einstein Condensate, the flow field must develop an array of vortices, which are whirlpools similar to tornados or the flow of water in a flushing toilet. The whirlpools in a Bose-Einstein condensate are quantized – when an atom goes around the vortex core, its quantum mechanical phase changes by exactly 2π. Wolfgang Ketterle's group has recently observed the formation of highly ordered vortex lattices in a rotating Bose-condensed gas. Stirring the condensate with a laser beam, sets it into rotation, and causes as many as 100 vortices in the gas cloud. Since the vortex cores are smaller than the optical resolution, the gas is allowed to expand (without collisions) after the magnetic trap, in which it was created, is switched off. This magnifies the spatial structures twenty fold. A shadow picture of these clouds shows little bright spots where the light penetrates through the empty vortex cores.

A striking feature of the observed vortex lattices is the extreme regularity, free of any major distortions, even near the boundary. Such "Abrikosov" lattices were first predicted for quantized magnetic flux lines in type-II superconductors.

More information on the Physics Department can be found online at http://web.mit.edu/physics/.

Marc Kastner

CENTER FOR LEARNING AND MEMORY

The mission of the Center for Learning and Memory is to decipher molecular, cellular, neuronal ensemble, and brain systems mechanisms underlying learning and memory and associated cognitive functions such as perception, attention and consciousness.

In order to fully understand complex cognitive phenomena such as learning and memory, it is necessary to analyze them at multiple levels of complexity: at the molecular level, at the synaptic level, at the cellular level, at the neuronal ensemble level, and at the level of behavior of a whole living animal.

At the center we accomplish these challenging objectives by applying, in combination, an assortment of cutting edge experimental technologies that include behavioral mutants of fly, molecular and cell biology, genomics, electrophysiology of cultured neurons and brain slices, two photon laser microscopy, combined behavioral and single-unit recording and analysis of monkeys, large scale recording of the activity of neuronal ensembles of freely behaving rodents, and a wide array of behavioral paradigms

Two faculty joined the center this year: Professor Mriganka Sur, Head of the Department of Brain and Cognitive Sciences, and Professor Morgan H. Sheng. Dr. Sheng is Professor in the Departments of Brain and Cognitive Sciences and Biology and the inaugural holder of the Menicon Chair in the Neurosciences in the MIT School of Science. He is also Associate Investigator with the Howard Hughes Medical Institute and Investigator at the RIKEN-MIT Neuroscience Research Center.

The center established a faculty affiliates program for the purpose of promoting and sustaining stronger communication and interaction among the different neuroscience units at MIT. In recognition of the excellence of their research and its particular relevance to CLM, four faculty affiliates were announced in 2001: Professor Martha Constantine-Paton, Department of Biology; Professor Ann M. Graybiel, Department of Brain and Cognitive Sciences; Professor William G. Quinn, Jr., Department of Brain and Cognitive Sciences; and Professor H. Sebastian Seung, Department of Brain and Cognitive Sciences.

Professor Earl K. Miller was appointed as Associate Director of the Center for Learning and Memory, and Donna Maria Ticchi was appointed as Assistant Director for Administration.

In June 2001, the Picower Foundation pledged a major gift for the Center for Learning and Memory. Funds will be used toward the construction of the new neurosciences building complex at MIT, four professorships for CLM faculty, and an endowment for CLM research operations. The neurosciences complex is currently in the planning stages, and CLM anticipates moving into its own new building in a few years.

FACULTY RESEARCH DEVELOPMENTS

Yasunori Hayashi's laboratory focuses on a region in the brain called the hippocampus, which is buried deep in the cerebrum. To study the phenomenon called long-term potentiation (LTP), the lab combines different technologies. They construct various recombinant neuronal proteins and express them in neurons using molecular biological techniques. Then they analyze the expressing cells using electrophysiological and two-photon microscope techniques. They also study another peculiar phenomenon in the hippocampus: neuronal regeneration. They use a genetically altered animal to specifically ablate this process and study the effect of loss of neuronal regeneration on learning and memory. Through these analyses, they would like to know the molecular events that mediates memory in the mammalian brain.

The focus of research in J. Troy Littleton's laboratory is the elucidation of the molecular mechanisms underlying synapse formation, function and plasticity. They combine molecular biology, protein biochemistry, electrophysiology, electron microscopy and imaging approaches with *Drosophila* genetics to investigate molecular mechanisms involved in neuronal signaling. Current genetic approaches in the lab include the identification and characterization of novel temperature-sensitive paralytic mutants in *Drosophila* as a tool to identify and study new components of neuronal signaling pathways. Many of these temperature-sensitive paralytic mutants alter synaptic sprouting, membrane excitability or synaptic transmission, thus allowing the researchers to pursue novel gene products involved in epilepsy, synaptic plasticity and synapse stability.

Guosong Liu's laboratory studied the functional maturation of glutamatergic synapses, a critical process during the formation of functional neural networks. They found that synaptic transmission at newly formed synapses is functionally "silent." In contrast to the prevailing hypothesis that silent synapses lack functional AMPA receptors, they found that these synapses contain functional AMPA receptors, but cannot release transmitters from presynaptic terminals properly. These results suggest that one aspect of synaptic maturation is an enhancement in the flux of transmitter delivery into the synaptic cleft and point out new directions for identifying the locus of synaptic plasticity.

The ability to group stimuli into meaningful categories is a fundamental cognitive process, but its neural basis has been a mystery. To explore this, Earl K. Miller's laboratory trained monkeys to categorize computer-generated

stimuli as "cats" and "dogs." A morphing system was used to systematically vary stimulus shape and precisely define the category boundary. They found neural correlates of these categories in the lateral prefrontal cortex, a brain region associated with the highest levels of cognitive function. Also in the lab, they discovered that the ability to abstract principles or rules from experience allows behavior to extend beyond specific circumstances that have been directly experienced. For example, we learn the "rules" for restaurant dining from specific experiences and can then apply them to new restaurants. They explored its neural basis by recording from single neutrons in the prefrontal cortex (PFC) of monkeys trained to use two abstract rules. They were required to indicate whether two successively presented pictures were the same ("match") or different ("nonmatch"), depending on which rule was currently in effect. The most prevalent neuronal activity observed in the PFC reflected the coding of the "match" and "nonmatch" rules.

Elly Nedivi's laboratory has developed a highly sensitive subtractive cloning and differential screening method that has allowed them to identify and isolate a large pool of genes involved in neuronal plasticity. These 377 candidate plasticity-related genes (CPGs), approximately 210 of them novel, constitute the basis of study. One of the CPGs currently under full-scale investigation in the lab is CPG2. They found that CPG2 is a structural protein that is localized to dendritic spines and interacts with the actin cytoskeleton. Because of its similarity to members of the spectrin/dystrophin protein family, it is possible that CPG2 also functions to regulate attachment or localization of synaptic components to the membrane and/or cytoskeleton. Since CPG2 was cloned on the basis of its activity-dependent expression, it is intriguing to consider that it may also play a role in linking levels of neuronal activity and anchorage or distribution of synaptic components.

Morgan H. Sheng moved his laboratory from Massachusetts General Hospital/Harvard Medical School to CLM in July, 2001. The Sheng laboratory is interested in the cell biology of neurons and the molecular architecture of synapses (the communication junctions between neurons). Changes in the molecular structure of synapses and the connections between neurons underlie the ability of the brain to remember and adapt to experience (brain plasticity). By studying synapses at the molecular level, using biochemical, genetic and imaging approaches, they aim to discover the most fundamental mechanisms of brain plasticity. Current research is focused on the cell biology of glutamate receptors (the proteins that bind to the neurotransmitter glutamate and that mediate postsynaptic excitation) and on the regulation of dendritic spines (the specialized morphological compartment on which excitatory synapses are formed).

Mriganka Sur's laboratory, which joined CLM in October, 2000, demonstrated several basic mechanisms of plasticity in the developing and adult brain. In developing animals, his laboratory showed that mice lacking genes for ephrins A2 and A5 exhibit pronounced plasticity of retinal projections directed to the auditory thalamus. The ephrins act as barriers that normally prevent such plasticity. In adult animals, his lab showed that visual cortex neurons exhibit much greater plasticity of orientation tuning at pinwheel centers rather than at orientation domains. The basis for this difference is that neurons at pinwheel centers integrate inputs from diverse orientations, while neurons in orientation domains receive input from a narrow range of orientations. His laboratory showed that visual cortex in alert monkeys also exhibited orientation plasticity based on previously viewed stimuli, and such plasticity would serve to enhance the discrimination of orientations during the viewing of natural scenes.

Research in Susumu Tonegawa's laboratory focuses on the molecular, cellular, and neuronal ensemble mechanisms underlying learning and memory and associated cognitive functions of rodents. Their primary approach is to produce genetically engineered mice and analyze them with multifaceted approaches including molecular and cellular biology, histochemistry, electrophysiology of neuronal culture or brain slices, fluorescence-based microscopy, multielectrode physiology of awake animals and behavioral tasks. During the past year Tonegawa's laboratory made a groundbreaking discovery on the biological mechanisms of memory recall. It is our real life experience that the rich content of a memory can be recalled with very limited cues. This phenomena, referred to as "pattern completion," has fascinated many brain researchers but no underlying biological mechanism has been identified. By creating and analyzing a new strain of mouse in which a specific gene encoding a type of glutamate receptors (called NMDA receptors) is "knocked out" from a tiny brain area called area CA3 of the hippocampus, Tonegawa's laboratory identified a protein and an area of the brain that play a crucial role in memory recall.

Research in Matthew A. Wilson's laboratory addresses the question of how memories are formed and maintained within the mammalian nervous system. Of particular interest is the possible role of sleep in the long-term establishment of memory. By studying the interactions between brain areas using simultaneous neural recording techniques, they are pursuing the flow of mnemonic information during awake and sleep states between brain areas involved in memory formation and areas involved in higher-level cognition and decision making. They have found evidence of the formation of memory representations that generalize across experience based on similarity of temporally sequenced events. They have also recently found direct evidence of dreaming in rodents by identifying the reactivation during REM sleep of memory patterns established during recent awake experience.

FACULTY HONORS AND AWARDS

Yasunori Hayashi received the Ellison Medical Foundation New Scholar in Aging Award.

J. Troy Littleton received the Searle Scholar Award and the James and Patricia Poitras Scholar Award in Neuroscience.

Guosong Liu was promoted to Associate Professor in the Department of Brain and Cognitive Sciences.

Morgan H. Sheng was named the Menicon Professor in the Neurosciences.

Matthew A. Wilson was awarded tenure in the Department of Brain and Cognitive Sciences.

More information about the Center for Learning and Memory can be found online at http://web.mit.edu/clm/.

Susumu Tonegawa

GEORGE R. HARRISON SPECTROSCOPY LABORATORY

The George Russell Harrison Spectroscopy Laboratory conducts research in modern optics and spectroscopy for the purpose of furthering fundamental knowledge of atoms and molecules and pursuing advanced engineering and biomedical applications. Professor Michael S. Feld is Director; Professor Jeffrey I. Steinfeld and Dr. Ramachandra R. Dasari are Associate Directors. As an Interdepartmental Laboratory, the Spectroscopy Laboratory encourages participation and collaboration among researchers in various disciplines of science and engineering. Professors Moungi G. Bawendi, Feld, Robert W. Field, Stephen J. Lippard, Keith A. Nelson, Steinfeld, Andrei Tokmakoff, all of the MIT Chemistry Department, and Dr. Dasari are core investigators.

The laboratory operates two laser resource facilities. The MIT Laser Biomedical Research Center (LBRC), a Biotechnology Resource Center of the National Institutes of Health, develops basic scientific understanding, new techniques and technology for advanced biomedical applications of lasers; core, collaborative and outside research are conducted. The National Science Foundation-supported MIT Laser Research Facility provides resources for core research programs in the physical sciences for 13 MIT Chemistry and Physics faculty. Information about the facilities of the LRF and the LBRC can be found in the Spectroscopy Laboratory Researcher's Guide.

RESEARCH HIGHLIGHTS

Professor Field and his associates discovered a route to "transition state spectroscopy" in the S_0 state barrier region between acetylene and vinylidene. The *cis-trans* isomerization barrier on the S_1 potential surface has been characterized. Field's group is collaborating with Professors Fleming Crim (U. Wisconsin), Soji Tsuchiya (Japan Women's University) and Anthony Merer (U. British Columbia) to analyze these interactions, and with Drs. J.K.G. Watson (Steacie Institute, Ottawa) and Matthew Jacobson (Columbia U.) to calculate the Franck-Condon factors needed to disentangle overlapping polyads illuminated via multiple "bright states". Professors Field, Frederic Merkt (ETH Zurich), Anthony Merer (UBC), and Christian Jungen (Aime Cotton, Orsay) studied electron-nuclear coupling dynamics in Rydberg states of the alkaline earth monohalides, and identified the optimal "launch state" from which to record millimeter-wave spectra of CaF.

Professors Field and William Green (Chemical Engineering, MIT) constructed a free-radical spectroscopy, dynamics, and kinetics facility. A variety of high sensitivity spectroscopic schemes, including a Herriott cell and an ultraviolet cavity ring-down (CRD) setup (collaboration with Professor Jeffery Steinfeld) yielded initial results. A systematic CRD study of the acetylene S_1-S_0 transition in the 210-240 nm spectral region has been completed.

Professors Field and Steinfeld, in collaboration with Drs. Manjula Canagaratna, Stephen Coy and Alexander Kachanov, used intracavity laser absorption spectroscopy to carry out a rotational analysis and make quantitative intensity measurements of the $3\nu_1$ band of HONO. This study provides refinements to the current model for solar generation of atmospheric OH radicals by near infrared absorption and dissociation of NOX species. The capabilities of this instrument are being extended to carry out kinetic intracavity absorption spectroscopy, which will enable time-resolved kinetic measurements to be carried out on weakly absorbing species.

Professor Bawendi and Dr. Hans-Jurgen Eisler, collaborating with a group at Los Alamos National Laboratory, showed that nanocrystal quantum dots undergo stimulated emission and, in collaboration with Professor Henry Smith (Electrical Engineering and Computer Science, MIT), they used microcavity resonators to obtain laser oscillations. Lasing in these systems had been discussed for the last decade, and this is the first demonstration.

MIT Professors Bawendi, Michael F. Rubner (Materials Science and Engineering), Klavs F. Jensen (Chemical Engineering), and Marc A. Kastner and Raymond Ashoori (Physics) investigated the physics of electron conductivity and the effect of charging on nanocrystal quantum dot solids. They discovered a Coulomb glass behavior, resulting in a power law decay of the conductivity of these thin films. They also discovered that charging the dots can control the intensity of the photoluminescence of a film of dots. This discovery is consistent with a previous speculation that dots that contain one electron or one hole are prevented from emitting a photon because of a fast competing Auger process.

Professors Mildred Dresselhaus and Katrin Kneipp, together with Drs. Gene Dresselhaus, Harald Kneipp and Ado Jorio, studied surface-enhanced Raman scattering of single wall carbon nanotubes on silver colloidal clusters at extremely high enhancement levels and discovered new effects, such as lowering the symmetry of the resonance Raman tensor and coupling and scattering power exchange between phonon modes, which can be explained in terms of the strong optical fields and very large field gradients in so-called "hot areas" on the metallic fractal cluster structures. Together with Dr. Sandra Brown, Dr. Paola Corio and Professor R. Saito, they also performed detailed analysis on the origin of the Breit-Wigner-Fano lineshape of the tangential G-band Raman feature of metallic carbon nanotubes.

Professor Michael Feld and Research Scientist Chung-Chieh Yu investigated photon statistics of the cavity QED microlaser. Measurements of microlaser output and second-order correlation were in good agreement with theory. The fluctuation time scale was found to exhibit a local maximum during the threshold. Numerical simulations for

the many-atom microlaser showed that the system scales according to single-atom theory, with a small perturbation due to cavity decay during atom transit time.

Professor Lippard and Dr. Yuji Mikata continued to develop an efficient method for photocross-linking of cisplatin-modified DNA and damage-recognition proteins by laser irradiation. Only upon photocross-linking can the interaction of cisplatin-DNA 1,3-intrastrand d(GpTpG) or interstrand cross-links with HMG1 domainB protein be detected. Photocross-linking is thus an effective tool for investigating the interaction of cisplatin-modified DNA with damage-recognition proteins under heterogeneous conditions such those in cell extracts or living cells.

Professor Nelson and Dr. Christ Glorieux demonstrated a novel form of imaging interferometry through which real-space images of propagating acoustic and thermal responses can be recorded. The results have important fundamental and practical applications in characterizing complex media such as viscoelastic liquids. In separate work, they demonstrated optical excitation and time-resolved observation of interface acoustic waves whose properties reveal the viscoelastic properties of both interfacial constituents. The method was used to study the complex shear modulus of glycerol at MHz frequencies under conditions of both weak and very strong shear wave attenuation. It provides a new window into the onset of shear wave propagation, i.e. the onset of solid-like behavior, in viscoelastic media. Working in collaboration with Professor Michael Fayer and Dr. Gerald Hinze of Stanford University, they demonstrated observation of translation-rotation coupling in complex liquids through direct time-resolved measurement of flow-induced molecular orientational responses. The results illustrate polarization-based isolation of translational, orientational, and coupled contributions to time-resolved signals.

Professor Tokmakoff and his collaborators used polarization-selective femtosecond Raman spectroscopy to study collective motions of molecular liquids and solvated proteins. In liquids, such experiments reveal distinct collective molecular motions associated density fluctuations, and in proteins large-scale vibrational motion of secondary structures along hydrogen bond coordinates are revealed. An amplified system capable of producing pulses as short as 30 fs in the mid-IR is currently being constructed to investigate the hydrogen-bond dynamics of liquid water.

Professor Alexander Rich and Drs. Bernard Brown and Dr. Eugene Hanlon used solid-state Raman spectroscopy to confirm the left-handed Z conformation of RNA's complexed with the Zα domain of the human RNA editing enzyme ADAR1 in crystals of the protein-nucleic acid co-complex, and showed that the RNA in the crystals was indeed in the left-handed conformation prior to solving the crystal structure.

Professor Kneipp, together with Dr. Harald Kneipp and Drs. Dasari and Feld, continue single molecule Raman studies and applied non-linear Raman scattering. They showeed that surface-enhanced antiStokes Raman scattering provides a two-photon probe with an effective cross section at least seven orders of magnitude larger than typical two-photon fluorescence cross sections. Together with Professor Dresselhaus, they used surface-enhanced Raman scattering on aligned small carbon nanotube bundles to study the lateral confinement of hot areas in the local optical fields in the vicinity of silver nanostructures, as well as the polarization properties of the local fields.

Professor Feld and Drs. Charles W. Boone, Dasari, Annika Enejder, Joseph Gardecki, Irene Georgakoudi, Martin Hunter and Adam Wax pursued basic and applied applications of lasers and spectroscopy in biology and medicine at the LBRC. Fluorescence, reflectance, Raman, light scattering spectroscopy and low coherence interferometry are being used for histological and biochemical analysis of tissues, diagnosis and imaging of disease, and cell biology applications. Clinical studies are being conducted with researchers from the Cleveland Clinic Foundation, Medical University of South Carolina, Brigham and Women's Hospital, Metrowest Hospital, Beth Israel/Deaconness Medical Center, and New England Medical Center. Clinical studies using tri-modal spectroscopy, the combined application of intrinsic fluorescence, diffuse reflectance, and light scattering spectroscopies, demonstrated successful diagnosis of dysplasia in Barrett's esophagus, the urinary bladder, adenomatous polyps, the oral cavity and the uterine cervix. Light-scattering spectroscopy has been used to measure and image sub-cellular structures much smaller than an optical wavelength. Novel low coherence interferometry techniques use two harmonically-related wavelengths to measure optical phase. Exceedingly small refractive index and length changes, tomographically mapped, have been used to study structure and dynamics of cellular organelles. Raman spectroscopy has been used to measure blood analytes with clinical accuracy and identify morphology of breast lesions. This experimental and theoretical work is advancing new laser diagnostic technologies in the fields of medicine and cell biology.

More information about the Laboratory can be found online at http://web.mit.edu/spectroscopy/.

Michael S. Feld

GEORGE R. WALLACE, JR., ASTROPHYSICAL OBSERVATORY

The George R. Wallace, Jr., Astrophysical Observatory (WAO) is a teaching and research observatory located in Westford, Massachusetts. Professor James Elliot '65 is the Director, Dr. David Osip '89 serves as the Assistant Director/Manager, and Mr. Richard Meserole has served as the Observatory Technical Specialist (Mr. Meserole left the observatory this spring and the search for a replacement is currently nearing completion). Other staff, usually students, are coordinated through research programs. Undergraduates working on the various projects are funded in part by NSF's Research Experiences for Undergraduates (REU) program and in part by NASA and NSF research grants to Prof. Elliot and Dr. Osip. Observing facilities consist of a 24-inch reflecting telescope and a 16-inch reflecting telescope, a four-bay shed with roll-off roof housing three Celestron 14-inch Cassegrain telescopes (C-14) as well as a 5.5-inch astrograph, and several Celestron 8-inch Cassegrain portable telescopes. Additional infrastructure includes a building housing electronics workshop, data analysis computer facilities, and observers' quarters. The primary instrument for the 24-inch telescope has been a portable high-speed CCD camera system (PCCD) mated to a custom optics box providing 5:1 field compression at the Cassegrain focus. All other telescopes are equipped with CCD (charge-coupled device) camera systems and dedicated control computers. Additional instruments used during the past year include several photographic cameras, and a moderate-resolution fiberoptic spectrograph.

A major facility upgrade is currently nearing completion at WAO. As part of this process, the entire 24-inch telescope was disassembled for the first time since it was built 30 years ago. A new drive system has been constructed with close-looped encoded stepper-servo motors mated to custom 10:1 reduction gearing for both axes. These drives are currently undergoing lab testing by graduate student Janet Wu '00 and are to be installed in the newly assembled telescope in August. A new telescope control system known as MOVE (designed originally at Lowell Observatory) is also being implemented. This new drive system will allow full computer control of all telescope motions tracking at both sidereal and non-sidereal (for solar system objects) rates with positional accuracy of better than 0.1 arcseconds. The primary and secondary mirror have been tested, re-figured, polished and re-coated; they will be re-installed in the newly completed telescope by the end of the summer. The resulting optical configuration is a substantial improvement over the previous system and should provide sub-arceseond performance.

This year, PCCD has been undergoing its own system upgrades in preparation for upcoming occultation observing campaigns (the original purpose for the portable system). Graduate student Michael Person '94 and undergraduate James Pate '03 have been carrying out the PCCD work under the supervision of Professor Elliot. A new Apogee CCD camera incorporating a high quantum efficiency, back illuminated SITe detector in a 1024x1024 (24 micron) pixel array has been purchased to serve as the prime camera for the updated 24-inch telescope. This camera is currently undergoing initial testing and performance evaluation on one of the C-14 telescopes in the shed. It will be mated to the 24-inch with a filter slider and under computer control later this summer. Development is now beginning on an implementation of the Lowell Observatory Instrument System (LOIS) for remote camera control. LOIS is a modular telescope and instrument control system developed as a collaboration between Lowell Observatory and the Planetary Astronomy Laboratory (http://occult.mit.edu/pal/) at MIT. It is currently in use for the MagIC camera (http://occult.mit.edu/magic/) at the Magellan I telescope in Chile (http://www.lco.cl/magellan_lco/). The WAO camera project is being primarily carried out as a Masters thesis project by graduate student Janet Wu under the supervision of Dr. Osip

Last year, course 8.287J/12.410J Observational Techniques of Optical Astronomy drew 11 students, who used the Wallace facilities for a variety of astronomical projects, including broadband imaging of star clusters to construct color-magnitude diagrams and moderate temporal resolution photometric imaging of asteroid light curves to deduce rotational characteristics. In addition, a new fiberoptic spectrograph system was used for the first time to allow students to do moderate resolution single target spectroscopy observations. This system will be enhanced to offer lower and higher resolution gratings and a second system will be available for the upcoming academic year. For subject 12.409 Observing the Stars and Planets, an additional 27 students used the observatory for laboratory work. In addition, several small group observing sessions have been offered for interested students to use the facilities as an extracurricular activity.

More information can be found online at http://web.mit.edu/wallace/.

David J. Osip

EXPERIMENTAL STUDY GROUP

The Experimental Study Group (ESG), now in its 31st year, has significantly grown beyond its original mission of providing personalized instruction in the core subjects to first year students at MIT. At the present time, ESG also serves as a teaching laboratory for approximately 35 undergraduates each year, as well as a center for educational innovation in hands-on, interactive seminars. Several of these seminars (SP287 Kitchen Chemistry and SP293 Robotics) have been exported to the regular curriculum and are now being offered as dorm-based seminars. We are working closely with various parts of MIT (including relevant academic departments, the Edgerton Center, Residential Life and Student Life Programs, and the Dean for Undergraduate Education) to continue these seminars and promote their growth, since they are directly in line with the Task Force's Report on Student Life and Learning to better integrate those two aspects of students' lives. ESG also manages to offer a varied and dynamic curriculum with an excellent staff-student ratio at the cost effective level of $137 per credit unit.

Finally, we have started a pilot project in getting our alumni more involved in various aspects of the ESG program, including mentoring freshmen, teaching subjects for credit, running seminars during IAP, offering internships and job opportunities for students, speaking at Friday luncheons, and participating in community activities (such as weekend trips). We are very excited about this new aspect of ESG and hope to work with others at MIT who are also engaged in getting MIT alumni re-connected with the Institute.

STUDENT STATISTICS

Seventy-one first year students enrolled for one or both terms in ESG, the highest enrollment of freshmen in ESG's 31 year history. ESG's freshmen were a very diverse group: 59 percent of students were female and 17 percent were underrepresented minorities, the highest percentages of each group in ESG's history. In addition, 20 percent of ESG freshmen were international students, including students from Bangladesh, Canada, Columbia, Ghana, Hong Kong, India, Indonesia, Japan, Korea, and Sweden. Thirty-five upperclassmen who had been in ESG as freshmen took one or two subjects in ESG, and 45 undergraduates who had not previously been in ESG enrolled in seminars or HASS subjects taught in ESG.

An important component of ESG includes undergraduate, graduate, and alumni teachingassistants who work closely with our staff and faculty in helping maintain our ability to offer high quality, personalized instruction. We employed 37 undergraduates (who collectively maintained a grade point average of 4.4) who were closely supervised by staff through a variety of methods, including participating in a weekly teaching seminar in the fall term, meeting regularly with staff members, and receiving written feedback through end of term freshman evaluations. We also utilized six graduate students (most of whom had been in ESG as freshmen) and one ESG alumna as teaching assistants.

STAFF AND FACULTY

ESG's administration was headed by Professor Travis Merrittand included Associate Directors Dr. Peter Dourmashkin and Dr. Holly Sweet, and Program Coordinator Julie Banda. They consulted on an annual basis with members of the ESG Advisory Committee who included Professor Alan Davison (Department of Chemistry), Professor Marc Kastner (Department of Physics), Dean Philip Khoury (School of Humanities, Arts, and Social Sciences), Professor Daniel Kleitman (Department of Mathematics), and Dean Robert Silbey (School of Science).

The physics staff included Professor Emeritus Robert Hulsizer, Dr. Peter Dourmashkin, and David Custer '82. The mathematics staff included Craig Watkins and two newcomers: Dr. John Lewis, a Senior Lecturer in the department of Mathematics, and Evelyne Robidoux who received her master's degree from the Department of Mathematics last year.

The chemistry and biology offerings at ESG were supervised by Dr. Patricia Christie. ESG also offered several HASS and HASS-D courses to its students. In the fall term, Mr. Custer taught 21W.730 Expository Writing and Dr. Lee Perlman taught 21L.001 Introduction to Western Culture. In the spring term, Professor Merritt taught 21L.004 Major Poets and Dr. Perlman taught 24.00 Problems in Philosophy.

ACADEMIC INITIATIVES

ESG continues to provide a milieux in which staff, faculty, and students can develop new subjects and new approaches to existing subjects. Perhaps our most exciting development has been the steady increase in the numbers of interactive seminars we have been able to offer at ESG (particularly in the spring term). New seminars this year included Greek Mathematics, Special Topics in Mathematics, and Psychology in Action. Seminars which have been run previously (including Kitchen Chemistry, Literature, Robotics, Transitions and Connections, and Writing Workshop) continue to attract a wide variety of students, particularly students from outside ESG who frequently say that ESG seminars are the only opportunity they have had since their freshman year to participate in a small interpersonal class with a hands-on focus. We will continue to support the continuation and growth of our seminar program, with an eye to exporting it to the regular curriculum wherever possible.

For the first time, ESG was able to offer its own recitation and tutorials in 6.001 Structure and Interpretation of Computer Programs. Ben Vandiver '00, a current graduate student in Course 6 and a former ESG freshman, ran the

recitations, and tutorials were handled by ESG upperclassmen. The smaller size of the recitation and the close contact between recitation instructor and tutors allowed students to receive more individualized and integrated attention. Feedback has been very positive and we hope to continue this arrangement incoming years.

Several ESG students participated in a UROP sponsored by Dr. Dourmashkin in which they helped develop experiments for the new Technology Enhanced Active Learning (TEAL) version of 8.02 Physics that will be offered this coming fall in the regular curriculum.

ESG has been active in developing web-based learning materials this year, for use both within ESG and in the regular curriculum. Dr. Christie maintains the course information for the Department of Chemistry's web sites in 5.111 and 5.112 Principles of Chemical Science, and has put the syllabus, readings, and assignments online for SP287 Kitchen Chemistry. She has also put online the problem sets and tests for both 7.012 Introductory Biology and 5.112. Mr. Watkins has placed several ESG math subjects online, emphasizing the use of Athena software for symbolic-manipulation computer applications, enhanced numerical methods, and computer graphics (including 3-D figures and animations). He has placed supplemental notes online for ESG's version of 8.02 Physics which includes extensive incorporation of 18.03 Differential Equations and computer animations to enhance analysis of wave motion.

ALUMNI INVOLVEMENT

The ESG Alumni Network (ESGAN) was created in October 1999 as a response to the requests of alumni who attended ESG's 30th anniversary celebration that fall to have more opportunity for contact with ESG than annual newsletters and occasional reunions. Glenn Iba '74 has served as ESGAN's president since its inception and has been instrumental in expanding the role of alumni at ESG. During this past year, ESGAN sponsored several new initiatives, including monthly Alumni Nights, alumni mentoring of ESG freshmen, and the establishment of annual reunions of alumni.

In addition, ESG alumni taught a variety of credit-bearing subjects at ESG (including biology, computer science, mathematics and physics) and ran several IAP seminars. ESG alumni also made significant financial contributions to ESG which were used to sponsor educational initiatives and community activities that are beyond the scope of the ESG base budget. It is clear that many ESG alumni feel a strong connection to ESG, and that ESGAN has helped facilitate and strengthen those connections.

AWARDS

ESG gave its own set of annual awards, including the Peter and Sharon Fiekowsky community service award (now in its second year) and the Todd Anderson excellence in teaching award (now in its fourth year). Both Mr. Fiekowsksy and Mr. Anderson are graduates of MIT and have established funding for annual prizes. This year, the Peter and Sharon Fiekowksy award was won by Megan Dyvbig '04 and Miriam Boon '02 for their outstanding contributions to the ESG community. The Todd Anderson teaching award was given to seniors Yvonne Lai, Philip Miller, and Nirav Shah who had demonstrated excellence in teaching at ESG over a sustained period of time.

One of our alumni, Seth Finkelstein '85, who is still an active member of our community, won one of the three Pioneer Awards given out by the Electronic Frontier Foundation in March 2001 for his work in founding the Censor ware Project and in decrypting filtering programs. This award has been recognized internationally and was recently written up the New York Times.

FUTURE DEVELOPMENTS

In the coming year, we plan to continue with our educational innovation (especially offering hands-on education, interdisciplinary subjects, residence-based seminars, and web-based instructional materials), and to promote the use of undergraduates in instructional capacities at MIT. We will continue to expand the use of alumni at ESG, particularly in terms of funding new projects and informally tutoring and mentoring our new students. We look forward to continuing to provide a unique place where staff, students, faculty, and alumni can come together to experiment with new ways of teaching and learning within a collaborative, intergenerational, and interdisciplinary community.

More information about the Experimental Study Group can be found online at http://web.mit.edu/esg/www/home.html.

Peter Dourmashkin, Travis Merritt, and Holly Sweet

LABORATORY FOR NUCLEAR SCIENCE

The Laboratory for Nuclear Science (LNS) provides support for research by faculty and research staff members in the fields of high energy and nuclear physics. These activities include those at the Bates Linear Accelerator Center and in the Center for Theoretical Physics. Almost half of the faculty in the Department of Physics conduct their research through LNS. During fiscal year 2001, the Department of Energy is expected to provide LNS a total of $28,815,000 in research funding.

EXPERIMENTAL HIGH ENERGY PHYSICS

LNS researchers in experimental high energy physics are active at a number of laboratories around the world, including CERN (Switzerland), SLAC (California), and Fermilab (Illinois). The overall objective of current research in high energy physics is to test as precisely as possible the Standard Model, which has been very successful in describing a wide variety of phenomena, and to seek evidence for physics beyond the Standard Model. LNS researchers are playing principal roles in much of this research, as described below.

At CERN, an LNS group has led the research program with L3, the largest of four detectors at the Large Electron Positron (LEP) Collider. In the past year, the energy of LEP was raised so as to enhance the probability of detecting the Higgs boson, the particle necessary for the existence of mass in the Standard Model. Despite intriguing hints of the Higgs in data from L3 and the other detectors, LEP was shut down in November, 2000, to make way for the construction of the Large Hadron Collider (LHC). LNS is involved in both large detector projects at the LHC viz., the CMS and ATLAS detectors. In CMS, LNS scientists are engaged in the development of the data acquisition system; in ATLAS the effort is mainly in the development of the muon detection systems. LNS scientists have considerable expertise in both of these areas and expect to be major participants in the U.S. effort at the LHC.

LNS researchers have played leading roles in exploiting the unique properties of the SLD detector at SLAC, which has now completed its data-taking. Final data analysis is underway. An LNS group is now participating in the BaBar experiment at SLAC, which has already produced important insights into the nature of charge symmetry/parity violation in the B-meson system.

The Collider Detector Facility (CDF) Experiment at Fermilab is designed to study the Standard Model and its possible extensions at the highest energy accelerator in the world, the Tevatron collider. Current objectives of CDF include studies of the "bottom" (b) quark, precision measurements of the mass of the W particle (the carrier of the charged electroweak force), and the search for possible quark substructure. After a major upgrade, in which LNS researchers assumed important responsibilities, the multi-year Collider Run II began in the spring of 2001.

The Alpha Magnetic Spectrometer (AMS) experiment had a very successful first flight on the Space Shuttle Discovery in June 1998. AMS is an experiment designed to look for cosmic anti-matter and evidence for dark matter by operating a large magnetic spectrometer above the Earth's atmosphere. The international AMS collaboration is composed primarily of particle physicists and is led by an LNS group. An upgraded version of the AMS spectrometer is under construction, and the experiment is scheduled for a several-year data-taking period on the International Space Station starting in 2004.

EXPERIMENTAL NUCLEAR PHYSICS

Experimental nuclear physics at present has two main thrusts: medium-energy physics and heavy-ion physics. LNS has active, leading groups in both of these sub-fields.

The focus of LNS medium-energy activities is of course the Bates Linear Accelerator Center, which is operated by LNS for the Department of Energy as a national user facility. Bates has been a premier national and international resource for nuclear and particle physics studies for more than two decades. Continuous (as opposed to pulsed) electron beams in the South Hall Ring have been produced in both storage and stretcher modes. Stored beam has been used to test components of the BLAST (Bates Large Acceptance Spectrometer Toroid) detector and internal gas targets, and, with polarized electrons, to commission the beam polarimeter. Extracted beam has been used in two highly successful experiments with the new Out-of-Plane Spectrometer system which probed different aspects of the structure of the proton.

LNS nuclear physics researchers are leading several important efforts at accelerator facilities other than Bates. These facilities include TJNAF (Virginia), LANSCE (New Mexico), DESY (Germany), and Mainz (Germany). The focus of these experiments is a detailed understanding of the properties of the proton, the neutron, and light nuclei.

LNS researchers are prominent in relativistic heavy-ion physics. The principal goal of this field is to probe the existence and properties of the so-called "quark-gluon plasma," a state of matter which is predicted to exist at temperatures and densities higher than those present in normal matter, and which may have been present in the very early universe. An LNS group leads the PHOBOS experiment on the Relativistic Heavy Ion Collider (RHIC) at Brookhaven; this group produced the first publication from this new facility.

THEORETICAL NUCLEAR AND PARTICLE PHYSICS

Research at the Center for Theoretical Physics (CTP) seeks to extend and unify our understanding of the fundamental constituents of matter. It seeks to advance the conceptual foundations of fundamental physics, especially as applied to the structure and interactions of hadrons and nuclei, new forms of matter which may be created experimentally or observed astrophysically, and the history and large scale structure of the Universe. A few examples of recent work are mentioned below.

String theory aims to unite the strong, electroweak, and gravitational interactions and to explain the observed hierarchy of particles and interactions. The CTP has a strong and diverse group in string theory with important ties to lower energy particle physics. Important work includes the study of instabilities of "branes"—extended objects that occur in string theory—and their implications for field theories of strings. CTP theorists are also very active in the exploration of matrix quantum mechanics, which may be the fundamental structure that unifies various versions of string theory, and the study of tantalizing connections between string theories in anti-de-Sitter space and conformal quantum field theories.

String theories suggest patterns of supersymmetry breaking which may have implications for physics at the energy scales of the next accelerators. CTP researchers have been exploring these patterns. Also, string theory and quantum gravity suggest that space-time may have other dimensions, which influence physical phenomena only indirectly. This has been an extremely active area in the past year, largely led by CTP theorists. Effects include manifestations of extra dimensions at energies quite close to those presently available at accelerators.

MIT theorists have been actively developing new calculational tools for the study of non-perturbative effects in quantum field theories. Variational methods, consistent with renormalization and adapted for easy numerical computation, have been developed and are being applied to problems that arise in the Standard Model.

A major thrust in the CTP has been in the area of lattice gauge theory, which provides a unique tool to solve, rather than model, quantum field theories beyond perturbation theory. The CTP led the development of a major collaboration on high speed computation in QCD, which was recently approved for funding as part of the DOE's SciDAC initiative. These efforts parallel a new thrust in the study of quantum chromodynamics (QCD) at finite density and pressure. CTP researchers have suggested novel effects, such as "color superconductivity," and explained how they may be observed in heavy ion collisions.

CTP researchers continue to lead the exploration of the spin and flavor structure of hadrons, as seen in experiments (many led by MIT faculty) at Bates, Jefferson Lab, DESY, and Brookhaven National Lab.

Finally the CTP has initiated important work in quantum computing. New algorithms that exploit the adiabatic approximation in quantum mechanics offer hope of solving generic problems much faster than classical methods.

EDUCATION

Since its founding LNS has placed education at the forefront of its goals. At present approximately 86 graduate students are receiving their training through LNS research programs. A number of undergraduate students are also heavily involved in LNS research. Evidence shows that LNS educates a significant portion of the leaders of nuclear and high-energy physics in this country and abroad.

June L. Matthews

CENTER FOR CANCER RESEARCH

The Center for Cancer Research (CCR) was established in 1973 (actually opened in 1974) to study fundamental biological processes related to cancer. The goals of the center's research can be generally stated as developing an understanding of the genetic and molecular basis of cancer, how alterations in cellular processes affect cell growth and behavior, and how the immune system develops and recognizes antigens. These goals are related to the center's major research programs in oncogenes and mammalian genetics, molecular, cellular and developmental biology, and immunology. Approximately 248 people work in the center, distributed among the research laboratories of 13 faculty. In addition, six faculty members in the Whitehead Institute, five in Biology, one in Chemistry and one in the Division of Bioengineering and Environmental Health are Affiliate Members of the CCR.

Financial support for research in the center comes from many sources. The core of this support, which provides much of the funds for administration, partial faculty salary support, and central research facilities (i.e. glass washing facility, specialized laboratories and partial support for new faculty), is a Center Core grant from the National Cancer Institute. The current term extends to April 30, 2005. In addition to the core grant, the center's faculty have a total of 39 fully funded projects (plus >$606,000 of competitive support in fellowships for postgraduate studies). This support comes largely from the National Institutes of Health and the Howard Hughes Medical Institute, from industry, and from a variety of foundations supporting research in particular disease areas (American Cancer Society, Hereditary Disease Foundation, Muscular Dystrophy Association, National Neurofibromatosis Foundation, CaPCURE etc.). This latter type of support is particularly valuable for starting projects which later mature into federally funded grants. The center's success in attracting grant support is a reflection of the excellence of the research and educational activities of its faculty members. The FY2001 research volume was approximately $13.2 million, which does not include $4.25 million in additional support from the Howard Hughes Medical Institute.

Several groups in the center study the identities and functions of oncogenes and tumor suppressor genes. This work includes the recent identification of two genes disposing to acute myeloid leukemia as well as basic molecular studies on other oncogenes and tumor suppressor genes that regulate gene expression controlling the cell cycle and tumor growth. Another focus is on the biochemical mechanisms controlling RNA transcription and splicing, including studies of genes of the AIDS virus, HIV.

The immunologists in the center study the development of cytotoxic and helper T lymphocytes, their antigen-specific receptors, and the molecular mechanisms of antigen presentation and autoimmunity as well as the development and memory properties of B lymphocytes which produce antibodies. Since the immune response to tumors is poorly understood, these basic studies are crucial to a more profound analysis of tumor rejection. Immune cells can destroy cancer cells and it may be possible to stimulate this process. Furthermore antibodies to tumor antigens are proving very successful in tumor therapy.

The cell biologists study cell surface proteins involved in cellular adhesion and migration, as well as cytoskeletal proteins involved in cell motility and shape. Alterations in cell adhesion proteins contribute to the malignant phenotype of tumor cells including involvement in invasion, metastasis and angiogenesis. These proteins as well as cytoskeletal proteins are important targets for antitumor drugs, and deeper understanding of their structure and function should contribute to better therapeutic agents.

Since the cellular processes of development and cancer have much in common, useful insights into the behavior of tumor cells can be obtained from studies of normal embryos; several projects in the center focus on developmental processes. Recent advances in the generation of transgenic mice and mice with mutations in targeted genes are being exploited to investigate the roles of a variety of proteins important in tumorigenesis, including oncogene proteins, tumor suppressor genes, cell adhesion receptors, T-cell receptors and protein kinases. Major recent research advances include:

- The Jacks lab has developed several invaluable mouse models for cancer, including two which undergo metastasis.
- The Hynes lab has used genomic analyses to uncover genes that control crucial cellular processes in metastasis.
- The Chen lab has developed procedures for analyzing memory T cells, the cells that control immune responses and are the basis for immunization.
- The Hopkins lab has developed a new system to identify genes critical for development in the zebrafish, a genetically tractable vertebrate, and is using this system for rapid isolation of such altered genes.

In addition to its strengths in basic research, the CCR performs an important role in training future researchers in biomedical science, including undergraduate and graduate students, postdoctoral and clinical fellows. The faculty of the center fulfill critical roles in the educational programs of the Department of Biology. Extensive collaborations exist with medical schools, hospitals and the biotechnology/pharmaceutical industries. Thus, the research in the CCR has a major impact both on the fundamental understanding of cancer and on translation to and from the clinical arena.

A major strength of the center remains its attractiveness as an environment for the training of young scientists. The Center has 37 graduate and undergraduate students and 50 postdoctoral fellows/associates.

Two new faculty members joined the Center for Cancer Research in the fall of 2000. Luk van Parijs is working on autoimmunity (diabetes, arthritis, lupus). Michael Yaffe is working on signal transduction in growth control using cell biology, structural biology and bioinformatics.

It is a pleasure to report the following honors and awards to faculty of the center during this past year:

Tyler Jacks was promoted to Professor of Biology and will take over as Director of the center in July 2001, replacing Richard Hynes who served as Director for the last ten years.

Jacqueline Lees was promoted to Associate Professor with tenure and will be the center's new Associate Director as of July 2001.

Jianzhu Chen was promoted to Associate Professor with tenure.

Luk Van Parijs received the MIT Surdna Award. He was also selected by the Arthritis Foundation to receive the Satterfield Arthritis Investigator Award.

More information about the Center for Cancer Research can be found online at http://web.mit.edu/ccrhq/www/.

Richard O. Hynes

CENTER FOR SPACE RESEARCH

The Center for Space Research (CSR) conducts active research in astronomy, astrophysics, space science, space engineering and related technology, and participates in various National Aeronautical and Space Administration (NASA) flight missions. Specific areas of research include gravity-wave, X-ray, optical, radio, and radar astronomy; theoretical and experimental space plasma physics; planetary surfaces and atmospheres; and the space life sciences. CSR is heavily involved in several ongoing or upcoming NASA missions and supports MIT participation in several major research facilities. Research conducted in CSR is reported by the departments of Physics, Earth Atmospheric and Planetary Sciences, and Aeronautics and Astronautics.

HIGHLIGHTS

The Chandra X-ray Observatory (CXO), a major NASA mission launched in 1999, continues to operate flawlessly. Two of its four scientific instruments were built at CSR, the High-Energy Transmission Grating Spectrometer (HETG) (Professor Canizares, Drs. Dewey, Flanagan, Schattenburg) and ACIS, a Charge-Coupled Device (CCD) imaging spectrometer (Drs. Ricker, Bautz, Baganoff, Ford, Grant, Kissel, Mayer, Prigozhin). CSR is also active in the Chandra X-ray Observatory Science Center (CXC), which oversees the operation of CXO (Professor C. Canizares, Drs. Allen, D. Davis, J. Davis, Houck, Huenemoerder, Marshall, Schulz, Wise).

Highlights of high resolution imaging with ACIS include discovery of a rapid, 3-hour, 50-fold X-ray outburst from our Galactic center, providing compelling evidence that the X-ray emission is coming from a supermassive black hole (Drs. Baganoff, Bautz, Ricker); studies of dark matter in clusters of galaxies, confirmation that very massive clusters exist at high redshifts, supporting a low matter-density universe, the first high-angular-resolution X-ray observations of a gravitationally lensed quasar (Drs. Arabadjis, Bautz, Machacek, Ms. Jeltema, Mr. Malm, Mr. Morgan, Professor. Canizares, Schechter); initial studies of the compact object discovered in the supernova remnant Cas A (Professor Chakrabarty); studies of the population of X-ray sources in globular clusters (Mr. Pooley, Professor Lewin), and studies of jets from active galactic nuclei (Dr. Marshall).

High resolution spectra obtained with HETG have been used to probe material around active galactic nuclei, including discovery of dust in the ionized clouds, set limits on the warm component of the intergalactic medium, probe relativistic outflow from a galactic microquasar and spectral features in other X-ray binaries, measure composition and physical conditions in stellar coronae, stellar flares, and winds from hot, young stars, and study the abundances and dynamics of young supernova remnants, and the atmospheres of neutron stars (Drs. Allen, D. Davis, Dewey, Fang, Flanagan, Houck, Huenemoerder, Lee, Marshall, Ogle, Schulz, Wise, Mr. Stage, Professor Canizares).

The orbiting Bruno B. Rossi X-ray Timing Explorer (RXTE), named in honor of the late MIT professor, is now in its sixth year of operations. The light curves of more than 100 X-ray sources from the All-Sky Monitor (ASM, built at CSR) provide a new global view of the nature of the variability of the X-ray sky. Observations of rapid periodic and aperiodic behavior from neutron stars and black holes with the large-area instrument continue probe the physics of these objects and the predictions of General Relativity (Professors H. Bradt, Chakrabarty, Lewin, Drs. Levine, E. Morgan, R. Remillard, Mr. Miller).

A major milestone for CSR was the successful launch of the High Energy Transient Explorer (HETE-2) in October 2000. Built and operated at MIT with US and international collaborators, HETE-2 is dedicated to detect and promptly locate the sources of gamma-ray bursts (GRBs). HETE-2 is now providing positions to the GRB community within seconds of a detected burst, and recently yielded the best measurement of the hard x-ray spectrum of a soft gamma repeater. (Drs. Doty, Crew, Ricker, Vanderspek, Villasenor, Mr. Monnelly).

In radio astronomy at least three new gravitational lenses have been discovered (Prof. Hewitt with Prof Schechter). Hewitt and colleagues at Haystack Observatory continue work on the development of a large low-frequency array, which will also serve as a prototype for the future Square Kilometer Array, with goals of mapping the first structures that formed in the universe.

MIT is a member of the Magellan consortium, which is building two 6.5-meter diameter optical telescopes in Chile. The first of these was dedicated in December 2000, and is now operating. MIT (with Harvard and Carnegie) completed a permanently mounted camera, guider, and wavefront sensing system. The camera has already been used to search for optical counterparts to neutron stars and X-ray bursters, and to study gravitational lenses. The second telescope will begin science operations in October 2002. (Professors Canizares, Chakrabarty, Elliot, Schechter, Sussman, Dr. Osip, Mr. Boughan).

Studies of plasma in the solar wind continue from three spacecraft: IMP 8 and Wind (both near Earth) and Voyager 2 (currently at 65 AU). This past year was near the maximum in solar activity, and many large interplanetary shocks were observed near 1 AU. Studies of shocks associated with solar Coronal Mass Ejections which cause significant magnetic storms on Earth may enhance the storm predictive ability of spacecraft-based monitors. Data from Ulysses and Voyager 2, were used to trace such shocks to the outer heliosphere. A high-time-resolution solar wind experiment on the Triana spacecraft is expected to be launhed within two years.(Drs. Clack, Jurac, Lazarus, McGuirk, Paularena, Richardson, Wang, Professor Belcher, Mr. Kasper).

Data from the Laser Altimeter Instrument (MOLA) aboard the Mars Global Surveyor have been used to assemble a statistical description of changes in polar clouds as a function of the Martian season (Dr. Ford, Professor Pettengill).

CSR initiated design of virtual reality display devices, restraint systems, and software tools for the International Space Station (ISS) Human Research Facility. The system supports "VOILA" (Visuomotor and Orientation Investigations in Long Duration Astronauts), a set of nine flight experiments to be conducted on the ISS in 2002-2005 (Dr. Oman). Undergraduate and graduate students performed parabolic flight experiments to evaluate the "Micro-G" wireless version of Professor Newman's Enhanced Dynamics Load Sensor experiments. Professor Young continued as Director of NASA's National Space Biomedical Research Institute, which doubled in size this past year.

The MIT/Caltech Laser Interferometer Gravitational-wave Observatory (LIGO) Laboratory is continuing with the commissioning of the 4km-long interferometers at the Hanford, Washington and Livingston, Louisiana sites. Installation is complete and one interferometer at Hanford has successfully operated in the final optical configuration. Initial coincidence measurements will take place in the fall of 2001 for the first end-to-end data analysis effort. A five-year proposal for the continued operation of the Observatory and R&D for next generation instruments by has been submitted to the NSF. (Drs. Fritschel, Shoemaker, Zucker, Professors Katsavounidis, Weiss).

In theoretical cosmology, Professor Bertschinger has developed a new approach to calculating and interpreting anisotropies in the cosmic microwave background radiation and has developed a community code for preparing multiscale initial conditions for cosmological simulations. A model for gamma ray bursts from Kerr black holes formed in extreme supernovae, or hypernovae, in binary systems is being developed (Professor Joss), and other studies of binary system evolution are being continued (Professor Rappaport). A comprehensive model of the radio galaxy Her A has been completed (Professor Morrison), and a class of mesospheric modes has been found that can explain angular momentum transport in accretion disks in a wide range of astrophysical objects (Professor B. Coppi). Dr. Chang has developed an innovative theory of complexity in space plasmas in the Earth's magnetosphere using the concepts of forced and/or self-organized criticality and topological phase transitions.

Looking toward future missions, an initial agreement has been reached with the Japanese Institute for Space and Astronautical Sciences for CCD cameras for the Astro E-2 mission, and proposals have been prepared for several new efforts in X-ray astronomy, gamma ray bursts, UV astronomy, and human space flight (Drs. Bautz, Mayer, Oman, Ricker, Mssrs. Boughan & Goeke, Professors Canizares, Newman, Young). New technology is being developed for advanced X-ray CCD sensors (Drs. Bautz & Ricker, in collaboration with MIT Lincoln Laboratory) and novel X-ray optics (Dr. Schattenburg), with applications targeted to future NASA missions such as the Constellation X mission, the Micro Arcsecond X-ray Imaging Mission (MAXIM), and others. Research in CSR's Space Nanotechnology Laboratory (Dr. Schattenburg) seeks to apply micro and nanofabrication technology to achieve dramatic improvements in lightweight high-resolution optical components including foil-optic mirrors and diffraction gratings. As part of this effort fundamental advancements are being made in nanometer-accuracy lithography and metrology concepts, including fabrication of unique 200 nm-period free standing UV filters now flying on the Medium Energy Neutral Atom camera on the IMAGE satellite, to be launched in TWINS A and B in 2002, 2003, and gratings for NOAA's Geostationary Operational Environmental Satellites (GOES) missions N, O, P, & Q to be launched in 2002, 2005, 2007, and 2010.

More information about this center can be found online at http://space.mit.edu/.

Claude R. Canizares

CHAIR OF THE FACULTY

FACULTY POLICY COMMITTEE

In 2000–2001, the Faculty Policy Committee (FPC) oversaw those aspects of educational and academic policy that are specific responsibilities of the Faculty and provided faculty input toward policy development at the Institute. The committee met twice with the President, once with the Chancellor, and several times with the Provost. The FPC used these opportunities to convey faculty opinions on a variety of topics including intellectual property policies, the proposal to establish OpenCourseWare, the status of women and minority faculty at MIT, research administration policies, and campus planning.

The FPC charged the Graduate Strategy Group, a subcommittee of the Committee on Graduate Student Policy, with reviewing examination and term regulations governing graduate subjects and approved the recommendations resulting from that review. The Task Force on Minority Student Achievement, which was charged jointly by the President and the Faculty Chair, reported regularly to the FPC on its progress. The committee reviewed and coordinated the work of other faculty committees. It approved the recommendations of the committee on the Undergraduate Program regarding pass/no record grading and advanced placement policies and considered proposals to re-charter the Committee on Student Affairs and the Committee on Corporate Relations. In addition, the FPC approved the establishment of one graduate degree program, which was forwarded to the Faculty for a vote.

EXAM AND TERM REGULATIONS FOR GRADUATE SUBJECTS

In February 2001, the Graduate Strategy Group, a subcommittee of the FPC, concluded its review of exam and term regulations governing graduate subjects. As a result of this review, the FPC approved this addition to Section 2.54 of the *Rules and Regulations of the Faculty:*

> When a student is unable to take a test that is held outside of scheduled class time owing to a conflict with another scheduled academic exercise or extracurricular activity, the student shall be allowed to take the test at another time.

This change was presented to the Faculty at its February Meeting and approved in March. The revised regulation took effect on July 1, 2001.

TASK FORCE ON MINORITY STUDENT ACHIEVEMENT

In the fall of 2001, the President and the Faculty Chair jointly charged a Task Force on Minority Student Achievement with assessing the performance of minority students at MIT and making recommendations on how their experience might be improved. The Task Force, chaired by Professor John Essigmann, met regularly throughout 2000–2001 and gathered extensive quantitative and qualitative data. The Task Force reported to FPC on its progress at several points during the year and is expected to present its final report and recommendations in Fall 2001.

PASS/NO RECORD GRADING AND ADVANCED PLACEMENT POLICY

In February, the FPC heard the final recommendations of the Committee on the Undergraduate Program (CUP) on changes to pass/no record grading and advanced placement policy. Professor Robert Jaffe, chair of the CUP, conveyed the recommendations of the CUP and its subcommittee, which can be found online at http://web.mit.edu/faculty/reports/pnrap/. The recommendations addressed pass/no record grading, grading in the second year, prerequisites, and advanced placement credit. The FPC endorsed the recommendations of the CUP, which were then forwarded to the Faculty for approval.

PROPOSALS TO RE-CHARTER THE COMMITTEES ON STUDENT AFFAIRS AND CORPORATE RELATIONS

In the spring, the FPC considered proposals to re-charter the Committee on Student Affairs and the Committee on Corporate Relations. The goal of these proposals is to reinvigorate the committees and ensure that their charge is relevant to the current administrative structure and the needs of the Institute. The FPC agreed that revisions to the charter of the Committee on Student Affairs (CSA) would strengthen its role in supporting the Office of the Dean for Student Life and respond to the restructuring of that office, but members felt that the specifics of the proposal warranted further discussion. The CSA will return to FPC in fall 2001.

With respect to re-chartering the Committee on Corporate Relations (CCR), the FPC agreed that the role of this committee in providing oversight for the Industrial Liaison Program was no longer relevant but felt that the proposal to disband the existing committee and establish an FPC subcommittee required further consideration. The Committee on Corporate Relations will continue discussion of its role in fall 2001.

APPROVAL OF DEGREE PROGRAMS

The FPC approved a proposal to establish an S.M. in Science Writing, which was forwarded to the Faculty at its April meeting and approved in May.

COMMITTEE ON THE UNDERGRADUATE PROGRAM

The CUP Subcommittee on Freshman Pass/No Record Grading and Advanced Placement Policy submitted its report and recommendations to the CUP in late September 2000. The CUP engaged in extensive discussions with members of the faculty and student community throughout the academic year. The subcommittee, chaired by Professor Charles Stewart, made recommendations that formed the basis for four motions that were presented by the CUP to the Faculty in March 2001. In April, the Faculty approved a change in second-term freshman grading, to take effect in September 2002. Under the new policy, second-term freshman grades will be reported on the basis of A-B-C/No Record. Other actions taken by the Faculty in April included approval of a five-year experiment to allow sophomores to elect one "Exploratory Subject" each term, affirmation of the right of instructors to enforce prerequisite subjects, and recommendation to strengthen the oversight of advanced placement policy.

A permanent CUP subcommittee, the subcommittee on the Communication Requirement, was formed over the summer and began meeting in October 2000. The initial work of the subcommittee, chaired by Professor Steven Hall, was focused on implementation of the new requirement, particularly with respect to the administrative processes needed to support it. The subcommittee presented to the CUP its draft report to the Faculty in both January and February.

The CUP Working Group on Undergraduate Advising, chaired by Professor Mark Schuster, gave a preliminary report in March that called for CUP to take an aggressive role in undergraduate advising, and recommended the establishment of a set of standards. Throughout the spring term, the CUP worked to develop priorities for undergraduate advising and mentoring. In May, Professors Jaffe and Schuster met with all faculty undergraduate officers to discuss a draft position paper. Also in May, the Faculty approved a motion to include undergraduate advising as part of the formal responsibilities of the CUP as outlined in Section 1.73.2 of the *Rules and Regulations of the Faculty*. A draft charge to a CUP working group of undergraduate mentoring has been prepared; it is expected that this group will continue the work begun during 2000–2001.

CUP business in other areas included the following:

- The CUP heard presentations from 6.001 lecturer Professor Eric Grimson and Physics Professor Edmund Bertschinger about teaching innovations being introduced that eliminate some or all of the classroom lecture. In response to some concern about the elimination of face-to-face time between students and faculty, the chairs of the CUP, Committee on Curricula (COC), and FPC issued a letter to the faculty in April. The letter reminded faculty of the role of the COC in approving new subjects or changes to existing subjects, adding that the faculty committees intend to be especially careful in approving proposed subject changes when actual contact time is reduced.
- Members engaged in a series of discussions about the deliberations of the Council on Educational Technology and its Lifelong Learning Initiatives team. CUP discussions were influential in shaping the final form of the OpenCourseWare proposal.
- The CUP received several progress reports from Professor Kip Hodges as he launched a pilot freshman subject, "Solving Complex Problems (Mission 2004)." The CUP approved Professor Hodges' request that students enrolling in "Mission 2005" in the fall of 2001 be allowed to exceed the credit limit by three units.
- The CUP approved the continuation and expansion of the Visual Arts Cross Registration program with the School of the Museum of Fine Arts and the Massachusetts College of Art.
- CUP members expressed enthusiasm for a proposal from Professor Alan Brody to create a Freshman Arts Program and asked that he return when the plan's fiscal aspects had been addressed.
- The CUP heard plans regarding the student exchange program of the Cambridge-MIT Institute.

OTHER FACULTY COMMITTEE REPORTS

Professor Leslie K. Norford chaired the Committee on Academic Performance (CAP), which reviewed 523 petitions during 2000–2001, a drop of four percent from the previous year. The change represents normal fluctuation: the 1999–2000 total of 547 was 2 percent higher than that of 1998–99. The number of petitions handled administratively by the chair and committee staff dropped from 229 to 161, in part because of the change in leadership of the committee. Although it was noted as a concern last year, the number of petitions in the category of "administrative neglect" decreased from 229 to 188. This year, fewer students (40) petitioned for late registration following a financial hold.

The other major form of Committee action consisted of reviews of end-of-term grades in January and June. These reviews led to 330 academic warnings and 38 required withdrawals. The number of warnings was 13 percent lower than the previous year and the number of withdrawals was six percent higher. As in the previous year, the number of warnings decreased monotonically from the first to the fourth year. Compared to the previous year, fewer seniors (six versus eleven) and more freshmen (nine versus five) were required to withdraw.

Table 1. End-of-Term CAP Actions (by Class Year)

	2000–2001		1999–2000	
	Warnings	Required Withdrawals	Warnings	Required Withdrawals
Year 4	50	6	69	11
Year 3	69	12	72	10
Year 2	74	11	107	10
Year 1	137	9	133	5
Totals:	330	38	381	36

The CAP chair worked closely with members of the CUP on two issues: implementation of the new Communication Requirement and a proposal to change the grading policy for second-term freshmen. The major issue with respect to the Communication Requirement was enforcement. It was agreed that when the Subcommittee on the Communication Requirement determines that a student is behind in the expected progress of a single Communication-Intensive subject each year, it will enlist the help of the CAP in reviewing the student's record and taking appropriate action. For freshman grades, the major issue for the CAP was a review of those students in academic trouble at the end of the first semester and having the flexibility to keep what is expected to be a very small number of students on a second semester of pass/no record grading.

The Committee on Corporate Relations (CCR) was chaired by Professor Arthur B. Baggeroer. Formed at the same time as the Industrial Liasion Program (ILP), the CCR discussed in depth whether it has outlived its usefulness. The purpose of the committee was to provide oversight to the ILP, but in its maturity, that program no longer needs the help of the CCR. In meeting with the Chancellor and the FPC, it was concluded that faculty representation in industrial partnership negotiations might be better served through an FPC subcommittee. The details of the Subcommittee on Corporate Relations will be resolved in the 2001–2002 academic year.

The Committee on Curricula (COC) met 17 times during the 2000–2001 academic year. It approved proposals for new, canceled, and revised subjects, including 72 new undergraduate subjects, and was responsible for approving substantive curricular changes and upholding policy. The committee agreed to a revision of language regarding minors and thesis titles that appears on the student transcript and diploma.

The COC approved substantive curricular changes to the undergraduate curricula in Mechanical Engineering, Brain and Cognitive Sciences, and Political Science; the minor program in Music; a new version of the Physics General Institute Requirement, 8.02T Physics TEAL (Technology Enabled Active Learning)/Studio Project; and changes to the experimental capstone Institute Lab subjects in Aeronautics and Astronautics.

The COC reviewed student petitions to pursue second S.B. degrees and for substitutions to the General Institute Requirements. The committee upheld its policy, effective March 3, 2000, limiting the number of S.B. degrees to two and prohibiting graduate students from petitioning to pursue S.B. degrees.

Other committee business included:

- discussion and endorsement of the CUP's recommendations on pass/no record grading and advanced placement policy;
- clarification of the COC's role with respect to the new Communication Requirement including working with the HASS Overview Committee to understand the criteria and approval process for CI subjects and approve 83 Communication-Intensive (CI) subjects;
- interpretation of Faculty rule regarding the 3-subject HASS overlap with departmental major requirements;
- discussion of web-based instruction including approval of web-based subject, 8.224, Exploring Black Holes: General Relativity and Astrophysics; and
- determining credit allocation and equivalencies across curricula as part of the establishment of the CMI student exchange program.

The Committee on Discipline (COD) heard charges against nine students this year, eight of which were for academic and one for personal misconduct. In addition, one charge was withdrawn, and three remained to be heard during the summer. The sanctions for the charges heard were varied, ranging from the severe (withholding a degree, expulsion, and suspension) to informal (including strong reprimands and sanctions tailored to the specific charges and circumstances). The committee reviewed a number of petitions to remove disciplinary notations from transcripts, as well as a petition to be allowed to receive a withheld degree.

As in the past, the COD, in conjunction with the Office of the Dean for Student Life, reported to the Faculty regularly on the disciplinary actions. Committee members hope that this practice alert faculty members to the need for consistent reporting of incidents and increases student awareness of the risks they run when engaging in academic dishonesty.

The Harold E. Edgerton Award is given to an outstanding member of MIT's junior faculty. The selection committee reviewed 13 nominations this year and awarded the Edgerton Prize to Dr. Justine Cassell of the Media Laboratory and Dr. Seth Lloyd of Mechanical Engineering. The selection committee acknowledged that these two extraordinary candidates are possessed of complementary strengths, and it was decided to let them share the award in tribute to the breadth of Doc Edgerton's abilities. Dr. Cassell works towards developing the technology to permit natural forms of human communication and linguistic expression in the digital world. The interdisciplinary nature of her work is manifest in the interactions and support she has across several departments and schools, and it is also a feature of the courses she has designed and taught. Dr. Lloyd is the international leader in the field of quantum computing, as evidenced by his plenary presentations at critical conferences and his publications in the general and high-profile journals *Science* and *Nature*. Dr. Lloyd's stellar research record parallels his commitment to teaching and community.

The Committee on Faculty-Administration (CFA) explored a number of issues, some of which had arisen during the preceding year. Committee business included discussion of the Institute's standing committees and other issues of Faculty governance, intellectual property, faculty housing, the faculty reward structure, the impact of international partnerships on faculty priorities, and the possible restructuring of the MIT Faculty Club. The CFA did not form a final recommendation on the restructuring of the Faculty Club and will add this issue to next year's agenda.

One recommendation of the 1998 Task Force on Student Life and Learning was to streamline the Faculty committee structure. In 2000–2001, the CFA reviewed both faculty committees and Institute committees to which faculty members are appointed. The outcome of this effort was a set of recommendations to the Provost and Chancellor regarding reduction of faculty members' obligation to Institute committees.

The committee to select the James R. Killian, Jr., Faculty Achievement Award for 2001–2002 sent out a call for nominations in December 2000. It reviewed 12 nominations submitted over the past three years (many of them updated) and one new nomination. This year, the award was presented to Professor Erich P. Ippen, Elihu Thomson Professor of Electrical Engineering and Professor of Physics. Professor Ippen is noted for his establishment of the field of femtosecond optics and for the breadth of the impact of his work on science, technology, and society. In addition, his abilities as a teacher, mentor, and colleague are held in the highest esteem. The overlap of one of the committee members from the previous year's committee again proved valuable.

The Committee on the Library System (CLS) met eight times during this academic year. In addition, the committee met with the Corporation Visiting Committee for the Library System and conducted extensive correspondence with members of the MIT community. Committee business included space planning and discussion of the impact of continued under-funding and information technology on the MIT Libraries.

The CLS continued to stress the need to increase substantially MIT's investment in its library system. The libraries must store 27 percent of the collection off-campus due to the lack of on-campus space and contend with the poor condition of much of the existing physical space on campus. The committee noted that MIT spends on libraries one-third as much per student and library staff are paid one-third less than librarians at peer institutions. Yet, MIT's collections are focused on the most expensive category of literature (science and technology) and are very heavily used by the community. The continuing growth of information technology in the libraries adds to the cost of operation but will not substantially reduce the space needs. After considering these various issues, the CLS has recommended to the administration that MIT build a new Science and Engineering Library with integrated facilities supporting student life and learning. This new library might be located on north of Vassar Street and east of Massachusetts Avenue. The committee also urges that the Hayden Library be renovated concurrently as an integrated Humanities, Arts, and Social Sciences Library. Construction of these facilities should begin within five to 10 years. The estimated cost of these two projects, $130 million, might be raised by setting these projects as priorities for the current capital campaign. The full scope of this committee's activities for 2000–2001 were documented in the collected proceedings.

The Committee on Nominations worked this year to restore the terms of service on faculty committees to two years. Several colleagues agreed to extend their terms by a year or two allowing for some continuity within each committee. At its May meeting, the Faculty approved 45 names for service in the faculty governance system.

In early December, the Committee on Nominations learned that Professor Jeffrey H. Shapiro, who had been confirmed as the Chair-Elect of the Faculty during the preceding spring, had been selected to become the Director of the Research Laboratory of Electronics. The committee was pleased when Professor Stephen C. Graves accepted its invitation to become the next Chair of the Faculty, and his appointment was confirmed at the March meeting of the Faculty. Professor Evelynn M. Hammonds agreed to continue in her role as the Secretary of the Faculty, and Professor Jacquelyn C. Yanch was elected the new Associate Chair.

During 2000–2001, the Committee on Outside Professional Activities (COPA) held discussions to reevaluate its role. COPA debated the best way to be of service to the MIT faculty, particularly in regard to coordinating its agenda with the recommendations of the Ad Hoc Committee on Intellectual Property and Conflict of Commitment. The other major topic covered in committee discussions was faculty supervision of theses and sponsored research projects under unusual conditions. COPA members discussed a situation wherein a thesis student was part of the

sponsoring organization, and the faculty member's research is sponsored by an organization in which s/he has a substantial financial or managerial interest.

The Committee on Student Affairs (CSA) formulated a proposal to re-charter. In light of the recent focus on undergraduate life, the CSA proposed aligning itself with the Office of the Dean for Student Life in a way that would make it possible for the committee to focus on policy issues. In the past the CSA has functioned as a clearinghouse for student concerns, but it could play a more active and substantive role in improving student life. This topic was discussed at a meeting of the FPC in April, and the CSA will return to the FPC in the fall of 2001 with a revised proposal.

Administrative changes within the committee included appointing staff support; establishing a permanent, biweekly meeting time; and arranging regular meetings between the CSA Chair and the Dean for Student Life. These meetings led to the setting of the CSA agenda, based on the issues and priorities defined through discussion with the Dean.

One outcome of the committee's work was the formation of an *ad hoc* subcommittee of junior faculty since their perspective is not represented on the CSA. This subcommittee has three young and/or junior faculty members who meet with the CSA. The committee named liaisons to various other working groups and committees at the Institute that wanted faculty representation (e.g., the Campus Alcohol Advisory Board and the Committee on Dining). These faculty members need not be members of CSA, but they extend the reach of CSA by representing faculty perspective and reporting back to the committee when input and discussion are necessary. The CSA also focused on issues related to community building *vis à vis* student-faculty interaction as recommended in the report of the Task Force on Student Life and Learning.

During 2000–2001, The Committee on Undergraduate Admissions and Financial Aid (CUAFA) conducted a comprehensive review of financial aid practices, particularly in regard to the cost disparity (now estimated to be in excess of $5,000 per year) between MIT and its competitors. Working with the Director of Student Financial Services and the Student Financial Services staff, CUAFA helped to implement a number of changes in the way MIT interacts with students in need.

In 1999–2000, CUAFA had renewed its commitment to helping MIT continue to attract the best students, this past year's discussions of financial aid practices were guided by concerns about accessibility and shifting demographics. Although funding has been increased to allow a reduction in the self-help level by about $2,000, the Institute's competitors have also intensified their efforts to attract top students from families with incomes in the $50,000–100,000 range. Accordingly, CUAFA continues to support the request for substantial increases in the level of financial aid that is made available.

CUAFA reviewed the facilities in the offices of Student Financial Services and found them to be inadequate for conducting private discussions of financial matters with families. The committee expressed concern that these facilities would project a negative or insensitive image of MIT. CUAFA urged that this situation receive immediate attention.

On the admissions front, CUAFA discussed the question of recruiting, particularly with regard to students who are traditionally hard to attract to MIT. CUAFA renewed its effort to encourage faculty to read freshman applications, with the result that 2000–2001 saw the highest faculty participation to date. For the second consecutive year, the admissions cycle saw a reduction of one percent in yield, to 58 percent. CUAFA will work with the Admissions Office to study the reasons for this decline.

Steven R. Lerman, Anna Frazer, Rebecca J. Tyler

EXECUTIVE VICE PRESIDENT

In last year's report I presented five administrative themes to guide development and evaluation of administrative operations and services. They are client orientation, collaboration, sustainability, accountability, and professionalism. The themes are means. The ends are enhanced service levels and greater cost effectiveness. The reports that follow provide specific examples of how these themes are becoming part of our everyday lives.

HIGHLIGHTS

Program Review in Central Administrative Areas

In June, the Provost and I announced the initiation of a program for reviewing central administrative areas periodically. Although some non-academic areas at MIT (such as the Office of Sponsored Programs and Athletics) have had the benefit of the Corporation Visiting Committee process, this has not been available generally to central administrative units.

After evaluating the applicability of MIT's visiting committee model and the review process in use at one other major research university (there are very few models!), and with input from department heads here, we have defined a program that will involve both internal clients and outside experts. It will be piloted in the coming year in Financial Systems Services and Information Systems. These departments are particularly well suited for the pilot program for a number of reasons, including the criticality of their services, their multi-dimensional operations, the effects of the external environment on both the demand and supply sides of their core business, and the breadth and diversity of their client base.

The program review will involve both an Internal Review committee of MIT faculty and staff and an External Review Committee, on which experts from outside MIT have agreed to serve. James Champy, Chairman of Consulting at Perot Systems and also a member of the Executive Committee of the MIT Corporation, will be the overall chair of the review. Ann Wolpert, Director of the MIT Libraries, will serve as co-chair of the Internal Review Committee. The Provost and I are the sponsors of the program review and Patricia Brady of my office is providing staff support.

With this new process, we intend to challenge ourselves with frank answers to key questions: Are we meeting internal client needs and expectations? Where are the gaps and how wide are they? How do we compare with the highest external standards in our technological prowess and professional leadership? Are we cost effective? Do we have a sustainable service organizational model? Stay tuned.

AAC II

During this year, we changed the size and reporting relationship of the Administrative Advisory Council (AAC I). Formerly comprising 13 administrative officers from across academic and administrative units, and reporting only to the Executive Vice President, the Council now numbers 17 and is jointly convened by and advisory to the Provost and me. The goals are: broader base for client input and concerns, reanimated collaboration between central service providers and clients (or end-users), and more direct communication among individuals at various nodes of key business processes.

Campus Construction

As noted in the report from the Department of Facilities, there are six projects under construction. 10 in the design phase, and many others being studied. More than 1.5 million square feet are under construction. Milestones for the year included the permitting of five major projects, two groundbreakings, and three new and significant architect selections.

Settlement with the U.S. Environmental Protection Agency and Justice Department

In April 2001, MIT successfully settled an enforcement action resulting from a May 1998 broad campus inspection by EPA, and in June, the Federal District Court approved the Consent Degree. One of the most significant requirements is that MIT design and implement an environmental management system. This work has begun, and it will be overseen by an Ad Hoc Subcommittee of the Institute Committee on Environmental Health and Safety.

Human Resources-Payroll Project

This major collaborative effort, which kicked off in the fall, will redesign relevant business processes and then implement SAP's HR-Payroll module. Human Resources, the Office of the Controller, Financial Systems Services, Information Systems, and representatives from the Institute's departments, labs, and centers are playing major roles in this critical project.

Financial Review and Control

A new streamlined process to replace MIT's existing financial statement reconciliation process was launched this year. The new process enhances MIT's already strong control environment, complements MIT's SAP and Data Warehouse electronic tools, and uses the time of department administrators and support staff as effectively as possible.

Budget Seminars
To improve cost effectiveness, one has to know costs and measure effectiveness against both internal service standards and external benchmarks. Budgets can be powerful tools if developed and accounted for in terms of specific services: for example, network, custodial, payroll, auditing, construction, design, employment, and accounting services, to name only a few. Budgets and accounts have to be properly developed to answer my key annual questions: What is the outside competition (in price and quality terms) for services that your department provides? What competitive advantage or disadvantage do (should) you have as an inside provider? As the President's "procurement officer" for administrative services, why should I buy from you? Neither budgets nor accounts had been developed and maintained to answer these questions. To address this fundamental deficiency, I convened two half-day budget seminars for the "chief financial officers" of the operating units that report to the Executive Vice President. The seminar concept was an effort both to convey what I need to see in budget proposals as well as to learn what issues confront the operating units that might be impediments to better budgeting and accounting. The seminars were enlightening for all of us and culminated in joint efforts to craft the FY2003 budget call letter, and to redesign budgets and SAP accounts by service programs.

PERSONAL PROFESSIONAL ACTIVITIES
I became a trustee of the College Board, gave the keynote address to a joint meeting of Chief Information Officers and Chief Financial Officers sponsored by EDUCAUSE and NACUBO ("The Technology of University Business in the 21st Century"), and contributed the chapter on budgeting to NACUBO's sixth edition of *College and University Business Administration*, the standard reference for business practices in higher education.

PERSONNEL
In my office, Marilyn Melithoniotes joined us as Executive Assistant supporting Patricia Brady, Stephen Immerman, and Janet Snover.

Following are the individual department reports.

John R. Curry

FINANCE
AUDIT DIVISION
The MIT Audit Division delivers audit services through a risk-based program of audit coverage including compliance assessments and financial, operational and technology reviews and audits. These efforts, in coordination with the Institute's external auditors, provide assurance to management and the Auditing Committee that good business practices and policies are adhered to, adequate internal controls are maintained, and assets are properly safeguarded.

FY2001 was the first full year of the Audit Division's operations under new leadership. The Division's structure was brought into focus with delineation of new teams responsible for functional areas of the Audit Plan: Financial and Compliance, Operational, and Construction. Each team draws support from a specified member of the Information Technology audit staff, thereby integrating systems expertise into examination of business processes. Brisk recruiting efforts resulted in key positions being filled, including a construction audit specialist, as well as audit positions in compliance and general audit management.

The Audit Division's scope of services is equal to the full extent of MIT's auditable activities. Allocation of audit resources across this broad spectrum is accomplished via a model for evaluating risks associated with individual units and/or operational processes, thereby determining a cycle of audit review. The resulting annual Audit Plan guides the assignment and completion of work, which is heavily biased (approximately 40 percent of audit resources, measured in available staff hours) toward assuring compliance with financial controls and requirements of research sponsors within individual academic, research and administrative units. Audit review of capital construction projects has become an increasingly important part of the plan (approximately 10 percent, with remaining time devoted to audits and review of operational processes, uses of technology and special projects. Time is also specifically allocated to staff development.

During the past twelve months, we evaluated the adequacy of compliance with Institute guidelines, policies and procedures, for control over financial activity in nine areas of Information Systems. This review noted no material exceptions, however a transition in financial management had allowed some degradation in controls that was remedied during the course of our audit work. Examination of the Center for Cancer Research's practices in the administration of sponsored research noted minor exceptions to Institute policies, and overall compliance with requirements. Financial control and compliance processes of the School of Engineering will be examined thoroughly in the upcoming year, with particular attention to measurement of this area's adaptation to new guidelines for Financial Review and Control, promulgated during this year

Operational controls were examined in the Travel Office and over the use of the MIT Visa Card, both areas of high visibility from a regulatory perspective. Each of these areas promotes strong accountability over travel and card privileges extended throughout the MIT departments, research labs, and central units.

Construction audit activities have focused on selected capital projects, including Stata Center (review of the architect contract and related payments), Baker House renovations, Building E18 renovations, and others. Reviews have identified potential recoveries and questioned costs of nearly $250,000. The construction audit process employs the services of several external audit firms, with both local and national presence. Selection of firms is based upon prior experience with the Institute and the project's construction management, in a competitive bidding process. The Division's Construction Audit Specialist consults regularly with project managers on the status of projects, and to identify areas of potential exposure that may be avoided contractually or with modifications in practices.

Our Information Technology Specialists have been welcome additions to several endeavors on the technology front, including involvement in the SAP HR-Payroll module implementation, the selection of a vendor for the replacement Libraries system, and participation in the "e-commerce" team launched by the Administrative Policies and Systems Coordinating Council (ASPCC). Cumulatively these and similar projects consume in excess of one full-time-equivalent audit staff, nearly 10 percent of our resources.

In addition, we have actively participated in the environmental health and safety initiatives that are being undertaken in connection with the recently executed consent decree with the U.S. Environmental Protection Agency and the Justice Department. This commitment will grow in the upcoming year. Involvement by Audit in this and the above projects demonstrates the division's willingness to foster positive change as part of a management effort, in addition to fulfilling the traditional role of independent assessor.

Despite considerable success in recruiting activities, the division's operations were impacted by the status of open positions remaining in excess of 2.5 full time equivalents (21 percent of total complement) throughout this period. For this and other reasons, with the support of executive management and the MIT Auditing Committee, we enhanced relationships with various strategic partners to co-source and outsource audit work in the areas of capital projects, MIT Medical, the Alumni Association, and the Office of Budget and Financial Planning. This effort recouped a significant portion of the gap in available audit resources created by the open positions, as well as gaining access to necessary expertise not resident on the Audit staff.

The Audit Division implemented in January 2001 a software package enabling automation of administrative aspects of the audit process (workpapers, scheduling, time tracking, and recordkeeping of audit findings). This not only brings the division to a peer level for automation, it provides the foundation for "industrial-strength" measurement, monitoring and reporting to the MIT Auditing Committee on status and results of the Audit Division's activities.

The role of audit committees in both public and not-for-profit organizations is being better defined by members of the audit profession and others taking a strong interest in matters of institutional governance. Recently the MIT Auditing Committee expanded their annual meeting schedule to three meetings, to permit additional time for topics of interest in concert with their mission. The committee is also in the process of adopting a charter that will lend momentum to the Audit Division's goals for monitoring internal controls and supporting the Institute's risk management processes.

We emphasize professional development on the part of all our staff. During the past year we are pleased to note two individuals, Martha Jane Gagnon and Michelle Jackson, completed the requirements for certification as Certified Internal Auditors. This marks substantial commitment to the profession of internal auditing on the part of these individuals, and brings the total of certifications division-wide to eight. Members of the audit staff find opportunities for training in their discipline, and affiliate with industry peers through conferences, seminars and group meetings. The Institute Auditor is a member of the "Little 10+" association of Ivy League and other peer institutions, which meets semi-annually.

The Institute Auditor is an active participant in several management groups. As a member of the Executive Vice President's Senior Management Team and the Administrative Systems Policies Coordinating Council (ASPCC), the Institute Auditor lends expertise in risk management and control in addition to staying abreast of new developments in broader Institute initiatives. The Institute Auditor has also recently joined the Budget and Finance Steering Group (BFSG), to provide an additional link between internal operations and the oversight activities of the Auditing Committee in financial affairs of the Institute.

Systems development and Discovery Team work from the preceding fiscal year culminated in the roll-out of the Roles Database as the central systems of record for certain authorizations in FY2000. Business processes to accompany Roles were substantially designed by the Authorization Process Improvement Team (APIT), led by Audit Manager Michael Bowers. Following the conclusion of APIT's responsibilities at the beginning of this fiscal year, the IS Business Liaison Team (BLT) took ongoing responsibility for carrying out APIT's recommendations, and assumed the new function of Central Authorizor (CA).

The CA is overseen by a committee chaired by the Institute Auditor, and comprises members of the Controller's Accounting Office, (CAO), I/S, and Financial Systems Services (FSS). Over the past several months the CA Oversight Committee working with the CA has formulated a charter, and has implemented many of the recommendations from the APIT. Broader membership of other process owners and members representing the larger

MIT community is anticipated as other administrative systems adopt the Roles Database to manage their authorizations.

The Audit Division has taken several steps to echo the Executive Vice President's five broad themes for MIT Administration within internal operations and audit practices. First among these is client orientation. Supporting our primary client, the MIT Auditing Committee, while providing value-added audit services Institute-wide, has been a longstanding commitment of the Audit Division, one that is met through careful attention to the concerns and potential exposures that face the administrative and academic staff and the faculty, researchers, and senior Institute personnel they serve.

The second theme, collaboration, has been demonstrated particularly in our approach to construction audit; this responsibility can only be met through close involvement by the audit team in the affairs of the Capital Projects group and project management. Our efforts in system implementation projects have also been carried out through strong collaboration, a mode which advances the needs of the auditor as well those of the overall project.

Sustainability is the third theme. Business solutions to audit findings must, as a first priority address the noted problem; to do this in a sustainable manner is the ultimate goal. Often management accountability (the fourth theme), reinforced through ongoing measurement, monitoring and reporting processes is a necessary ingredient in a sustainable solution. Improving and supporting management accountability is a goal for audit management in the upcoming year.

Professionalism is the fifth theme. Professionalism on the part of individuals comprising the Audit Division, as well as within the practices for the conduct of audit work, is an assumed standard for the internal audit function of an institution such as MIT. We recruit and retain people with professional certifications, support the ongoing maintenance of such certifications, and through communication and development nurture their understanding of their obligations as MIT internal auditors.

Finally, as the upcoming year progresses, the audit management team continues to explore and compare internal administrative practices for audit plan development, audit methodology and uses of technology to "best practice" standards, and consider opportunities to better leverage existing resources while meeting the Institute's goals for the division.

More information about the Audit Division can be found online at http://web.mit.edu/audiv/www/.

Deborah L. Fisher

FINANCIAL SYSTEMS SEVICES

Financial System Services (FSS) coordinates the development, delivery, and maintenance of financial systems for the Institute. Our mission is to support the ongoing implementation of SAP; ensure that the software increasingly meets the needs of our clients, i.e., MIT's departments, laboratories, and centers (DLCs); keep MIT current in terms of installing the appropriate new version of SAP and other related software; and work to further integrate MIT's business processes. This was a transitional year for FSS. Much of our effort was expended either fine-tuning various aspects of the SAP financial modules that are already operational at MIT, or else preparing for the implementation of the Human Resources/Payroll modules or for the implementation of SAP at Lincoln Laboratory.

The upgrade to version 4.6 of SAP was the most important piece of preparation that took place during the year. This upgrade, necessary to support the large-scale Human Resources-Payroll (HR-Payroll) and Lincoln Laboratory implementations presently underway, was successfully completed in January 2001. The transition to SAP version 4.6 represented a greater degree of change for the DLC enduser than previous upgrades, so community members were again called upon to assist with testing as well as to provide feedback on upgrade training, documentation and support plans. Shortly after the 4.6 upgrade was completed Executive Vice President John Curry and FSS held a reception to thank the community testers.

SAP's Internet Transaction Server, the backbone of SAP's web-supported application delivery, was implemented on a pilot basis with approximately 100 users from the MIT community and the Controller's Accounting Office (CAO). Available transactions include the creation, change and look-up of journal vouchers, and the verification of credit card charges. Although these services were very well received in pilot, security concerns prevented them from being offered to the general community during FY2001. These concerns have been addressed, however, and a full rollout is expected in the fall 2001, as is the delivery of Employee Self Service, a component of the HR-Payroll project that employs the same architecture.

The formal kickoff of the Human Resources-Payroll Project occurred last fall, and there are now parallel efforts underway. The first is the implementation of employee benefits data into the SAP HR-Payroll system in preparation for the November 2001 open enrollment. FSS and Benefits Office staff have been working to develop and deliver training and documentation on the new system. The second is the formation of several business process redesign teams. These teams are working to streamline Human Resources and Payroll business processes, review policies and procedures, and facilitate change issues that will accompany the technical implementation of the SAP HR-Payroll module. More than twenty such teams are planned to review the HR-Payroll business processes and practices, and produce the redesigns. FSS staff are participating on several of the business process redesign teams.

In preparation for multiple subsidiaries to occur within the MIT business environment, a Multiple Enterprise Structure Team was assembled with FSS, CAO and Information Systems (IS) representation. The team coordinated the effort to identify and modify SAP components and to adjust business practice to support transactions in a multiple enterprise environment. Another team worked in parallel with the first spin-off organization, Technology Review, to assess business needs, assist CAO with financial transfers, configure the system and deliver end-user training.

Lincoln Laboratory has chosen SAP as the replacement for several of their aging administrative computing systems. The Lab will participate in the Institute-wide Benefits implementation of the SAP HR-Payroll project beginning summer 2001 and will implement the first phase of the Plant Maintenance module in late 2001. Other SAP functionality will be introduced for Purchasing, Inventory, Human Resources, Property, and Accounting over the course of 2002–2003. The Lab also intends to implement a new data warehouse integrated with SAP as the primary source for administrative reporting and is exploring a new generation of SAP compatible web-based tools to simplify access for end-users. Financial Systems Services and Information Services are providing extensive support to the Laboratory for the SAP project.

FSS welcomed SAP User Group (UG) presentations by HR-Payroll Team members this spring and looks forward to continued HR-Payroll participation in SAP-UG throughout the next year. Likewise, this year, for the first time, the *Financial Systems Update* newsletter included an article about the MIT Human Resources Payroll Project. As MIT proceeds to implement the SAP HR/Payroll module, the *Financial Systems Update* will continue to provide news of this significant project.

In addition to publishing the newsletter, the *Financial Systems Update* Editorial Board in collaboration with the Administrative Advisory Council II, created the Financial Systems Quick Reference. This valuable and very popular reference, developed in response to a client need, provides information about the various computer systems used at MIT to perform and support the financial work of the Institute.

In another collaborative effort with the Administrative Advisory Council II, FSS contributed significantly to the effort to articulate the need for a clear, efficient, uniform method to process graduate student appointments. This resulted in the formation of the Graduate Aid Simplification Team, a business process redesign team of the Human Resources Payroll Project, with an FSS Community Support Team member serving as a co-leader. This group will recommend a clear and consistent method for making graduate student appointments.

Members of the FSS Community Support Team and IS staff, including individuals from the Business Liaison Team and Web Communications Services, are working together to develop a web site to facilitate administrative work at MIT. This effort responds to a client need for a consolidated point of access to information and resources. It also incorporates an Administrative Calendar, initially created by FSS CST staff working with the Administrative Advisory Council II.

Acting on behalf of CAO, the FSS Community Support Team developed tools, provided decision support, and delivered training to DLCs for rollout of the new Financial Review and Control procedures. DLC administrators were invited to participate in standard or tailored presentations designed to help them adapt the new financial review policies to their organization as well as to train their staff. New policy outlines, business practice examples and sample exercises were used to support the transition to the new procedures, and a new Data Warehouse tool to ease the review was demonstrated.

The FSS Community Support Team, in collaboration with MIT Organization and Employee Development, is developing a series of courses on managing finances. During this year the course in the Foundations of Financial Management was completed and piloted, and will be offered seven times during academic year 2001–2002. Courses in advanced financial management and the Institute budget process will be completed and piloted in FY2002.

During this year, FSS identified the need for an executive level group that would develop and maintain a broad strategic view and keep SAP-related initiatives prioritized in relation to MIT's overall vision of administrative computing. That need has been met with the formation of the SAP Strategic Planning Group (SSPG). This six-member group includes representatives of departments, laboratories and centers, as well as CAO, IS and Lincoln Laboratory. Demand for SAP-related services continues to outstrip available resources as SAP is increasingly viewed as the software solution to meet business efficiency and information

Charles A. Shaw

OFFICE OF BUDGET AND FINANCIAL PLANNING

The Office of Budget and Financial Planning (OBFP) is a professional service organization within the Institute's financial administration. Its mission is to support two client groups, the DLCs on one hand, and senior management on the other, as they pursue the most efficient allocation of financial assets consistent with the Institute's goal of continued excellence in education and research. The office is responsible for:

- Providing the DLCs with the expertise and tools necessary to develop and maintain budgets that meet the needs of the individual while providing accurate base data to the Institute's Financial Plan.

- Supporting senior management by monitoring the Institute's financial position and providing accurate and timely financial analysis, projections, and recommendations as part of the process of developing the Institute's strategic financial plan.
- Managing MIT's financial information asset through the development of innovative budgeting and financial modeling tools.

ADMINISTRATIVE THEMES INITIATIVES

In the course of FY2001 the OBFP refocused its activities within the framework of the five key administrative themes of client orientation, collaboration, sustainability, accountability, and professionalism outlined by the Executive Vice President in last year's report. Significant progress has been made in the following areas:

Client Orientation

During 2001 the office formally instituted a Client Partnership Program with the DLCs. The key points of this program are:

- Proactive participation by Budget Officers in Administrative Officers' meetings within their assigned DLCs.
- A concerted effort to tailor processes and systems to meet client needs.
- Periodic strategic planning sessions with the Assistant Deans and their fiscal officers.

The results of these efforts to date have been good. The budget preparation and submission process ran more efficiently than ever before, and at the request of the Assistant Deans and with the help of the Controller's Accounting Office, a new procedure for handling drafts was developed. This procedure processes drafts on a daily basis rather than on a monthly schedule, and drafts are reflected in the specific SAP cost objects that they are supporting rather than in a single generic draft account. This new procedure will be fully operational by the end of July 2001. In general, the staff of the OBFP strive to work with their clients as facilitators in financial matters. During a recent staff meeting a Budget Officer defined this role in the following way: "When a client comes to us with a request, we never say it's not our job. We work with the client to find a solution to the problem. In this way we are working to permeate the walls of the legacy information silos."

Collaboration

In addition to the revised draft process mentioned above, several important collaborative projects got under way during the past year. The underlying theme for all of them is streamlining processes and improving the quality of data available to the Institute. The Office of Budget and Financial Planning and the Controller's Accounting Office (CAO) are working on three such projects. The first involved the development of a single reporting hierarchy that will be used for all financial reporting. The goal of this hierarchy is to eliminate the need for "crosswalks" between data presented by the OBFP and data presented by CAO. The second was to review, modify, and update the General Ledger revenue accounts in order to capture the distinction between external and internal revenue and ensure consistency in the budgeting and posting of revenue. The third project involved the joint development with CAO of a standard quarterly GAAP reporting format. This format has already been adopted for quarterly budget and financial reports, as well as for the GAAP exhibits in the recently published FY2002 Budget Book.
Other noteworthy collaborative activities were to:

- Execute MIT's most recent tax-exempt bond issue in collaboration with the Treasurer's Office, the Controller's Accounting Office, and the Department of Facilities.
- Reconcile construction gifts reported by the Campaign vs. construction gifts and funds available in the MIT Capital Plan. This activity involves close collaboration with the Office of Resource Development, the Recording Secretary, and the Department of Facilities, and results in consistent projections for MIT senior management.
- Periodically forecast construction project cash flows and debt requirements under changing gift and project cost assumptions, for use in the 10-year financial plan and in the Building Committee decision-making process. This activity involves collaboration with the Department of Facilities, the Office of Resource Development, and the Treasurer's Office, as well as the Recording Secretary.
- Develop a new financial structure for Information Systems in conjunction with its financial officers and with CAO.
- Team with Facilities and internal Audit to update the Capital Project Approval Process.
- Provide the Technology Licensing Office with technical assistance during the design and development of their new system.
- Assist in the redesign of the Human Resources system: two budget office staff are active members of the design review and management organization teams, respectively.

Sustainability

The 10-year Financial Planning Model developed within the Office of Budget and Financial Planning has become a key tool used in the development of the Institute's Financial Plan. However, since its inception in 1997 it has developed, as a prototype, in response to emerging needs. To ensure its ability to sustain the plan and to improve and expand its functionality, we have begun a project to rework the existing model into a more structured and maintainable tool that can eventually be directly accessed by key Institute administrators. This project is on schedule, and we hope to begin testing the new structure in September. In addition, to ensure the sustainability of the existing processes we have undertaken a number of training initiatives:

- Training for the community in use of NIMBUS, which during this past year has established itself as a mature and useful front end to SAP for budget data submission and maintenance.
- Internal training and information-sharing sessions for the office staff dealing with procedures and best practices.
- Providing guidance to the DLCs in the appropriate use of the General Ledger accounts with an emphasis on the revenue portions of the ledger.

The Office of Budget and Financial Planning also is collaborating with Financial Systems Services and members of the community in developing an MIT budget and financial training module to be included as a standard offering in the Institute's selection of professional development options. The partnership program mentioned above also added a dimension of sustainability through knowledge transfer. Budget Officers are now more familiar with the work of their partner Administrative Officers and can and do help new Administrative Officers assume their duties within a department, lab, or center.

Accountability
Accountability is a key theme for us. Our office consists of a small group of highly skilled professionals who are personally committed to fulfilling their obligations and responsibilities. The group works as a team. Each person's contribution is often dependent on the work of others in the office and is critical to the team's collective added value. Although the first job requirement for our staff is to be a team player, each staff member is fully aware of his or her roles and responsibilities and clearly identifiable by our clients and administrative peers as the author or initiator of his or her business action. Over the past few years we have been refining the communication tools and techniques needed to clearly define roles and responsibilities within the context of specific projects.

Finally, our office maintains the Institute's budget system of record, NIMBUS, and is accountable for the accuracy and integrity of its data. In this context, over the past year PriceWaterhouseCoopers has conducted an extensive audit of NIMBUS on behalf of the Institute Auditor. I am very pleased to report that the audit reports very favorably on NIMBUS's controls, data integrity, and architectural integration with the Institute's SAP accounting system.

Professionalism
Professionalism tempered with courtesy is the cornerstone on which quality service to our clients is based. We constantly seek to maintain and improve our level of expertise, both in areas relevant to the mission of our office and in terms of individual knowledge and qualifications. During the past year OBFP staff members have been involved in the following activities:
- Hosting the Financial Officers Group conference, an annual meeting of budget and financial planning managers from the leading peer institutions, such as Harvard, Stanford, Penn, Yale, and others;
- Attending the Americas' SAP Users' Group (ASUG) Annual conference;
- Attending the EACUBO conference in Boston;
- Attending the American Association for the Advancement of Science annual conference;
- Attending the NACUBO/APPA Institute for Facilities Finance: Strategies for Developing the Facilities Portfolio;
- Attending the Conference Board Conference—Refining Performance Measurement to Align Organizational Goals and Create a High-Performance Organization; and
- Attending the Investment Management for Institutional Investors conference organized by NYU's Stern School of Business Administration.

In addition, we actively encourage individual staff members to enroll in credit courses for professional development. Several staff members are currently working towards or have attained certificates in: project management from the Project Management Institute, advanced accounting from the Northeastern University Management School, and the Massachusetts CPA. In addition, most of the staff has participated in individual development classes primarily in the areas of technology use and finance. Finally, I am very pleased to report that two members of our staff of 12, Robert Slauzis and Eileen Francis, have received the Institute's Infinite Mile Award as part of the recently introduced Rewards and Recognition Program.

In the coming year, we will continue our efforts to make all five key administrative themes operational. A significant example will be the migration of the Institute's 10-Year Strategic Financial Plan, which we introduced and developed over the past two years under the leadership of the Executive Vice President and the Executive Committee of the MIT Corporation, from a spreadsheet-based prototype into a sustainable, production-quality modeling tool. To this effect we have hired an expert modeler and class of 2001 graduate of the Sloan School of Management, Israel Ruiz, on a contract basis. Israel will convert the product into a fully modular, database-powered tool with clearly identified and easily maintainable modules for: business rule, architecture, engine, outputs, and reports, and user and system documentation. The project will start in July 2001 and will be completed by September 30, 2001.

Stefano Falconi

OFFICE OF THE CONTROLLER

The Office of the Controller includes the following groups:

- Controller's Accounting Office (CAO) provides general accounting and payroll services to the Institute including accounts payable, accounts receivable, travel, cashier, sponsored research accounting, general ledger, financial reporting, payroll, and retirement plans accounting.
- Procurement Office assists the MIT community in the procurement of goods and services—providing advice and services that ensure favorable prices, protective terms and conditions, and compliance with MIT and federal policies and procedures.
- Property Office is responsible for the accounting and asset management of more than 100,000 items of equipment that are both MIT- and sponsor-owned, and tracking all capital costs associated with buildings.
- Lincoln Fiscal Office provides accounting, payroll, cashier, cash management, and property control services to MIT's Lincoln Laboratory.
- Insurance Office purchases casualty, property, and construction insurance for the Institute and administers claims. (In FY2001, the Insurance and Legal Affairs Office was reorganized, with insurance procurement and claims administration taken on by the Office of the Controller and insurance-related legal issues moving to the Senior Counsel's office.)

SYSTEMS

Work on the SAP Human Resources-Payroll system, in particular the Benefits implementation, and the Lincoln Laboratory ERP/SAP projects began in earnest in FY2001. Some Controller's Office staff were assigned to work full time on SAP Human Resources-Payroll, and other individuals are participating in the Design Review Committee and various short-term project teams. At Lincoln Laboratory, project teams, timelines, team structures, known impacts, and role definitions were discussed and selected. Accounting and finance and property were selected as the Lincoln Fiscal Office functional areas for initial development.

The Controller's Office collaborated extensively with other central units and department, lab, and center staff in two major upgrades to the SAP financial accounting system during FY2001—the upgrade to SAP's version 4.6 in January 2001, which provided improvements to SAP's user interface, and the multiple enterprise structures upgrade, which was required to enable *Technology Review* initially and, in FY2002, Lincoln Laboratory, to be supported as separate financial entities in SAP.

Staff from the Controller's Office worked with Information Systems and Financial Systems Services on a project to purge selected data from the SAP production system, freeing up considerable computer disk storage space. This is an ongoing project—the next phase is identifying additional SAP data that can be electronically archived or purged.

CAO staff also participated in e-commerce initiatives with the goal of providing MIT departments, labs, centers, and affiliated groups the ability to accept payment for goods and services by credit card via the web. The project teams developed guidelines for e-commerce at MIT and both long-and short-term recommendations on developing an infrastructure to support on-line credit card processing. These also are ongoing efforts.

The Property Office completed the first full year of using the SAP Asset Module for capital costs associated with buildings, and the annual closeout of building costs was completed in SAP.

REPORTING

Reporting improvements continued to be made during FY2001, with this year's focus on improving internal and external revenue reporting and in providing quarterly financial statements. CAO collaborated with the Budget Office to revise and implement more accurate revenue General Ledger accounts and revenue accounting processes. FY2002 budgeting was done using the new revenue general ledger accounts, and the new account structure will be fully operational in FY2002. A quarterly close process was developed to support production of quarterly financial statements and the first quarterly financials for March 31, 2001 were presented to the Institute's Auditing Committee in June 2001. In retirement plans reporting, tax reporting changes required by the Department of Labor for the Basic and Defined Contribution pension plans also were completed in FY2001.

FINANCIAL REVIEW AND CONTROL

The Financial Review and Control project team, which consisted of departmental and central staff, completed its work, developing a new streamlined process to replace MIT's existing financial statement reconciliation process. Extensive training and documentation also was developed. Training of departments in the new process began in January 2001 and will continue into FY2002 until all groups have been trained. The new process enhances MIT's already strong control environment, complements MIT's SAP and Data Warehouse electronic tools, and uses the time of department administrators and support staff as effectively as possible.

AUDITS

Controller's Office staff both on campus and at Lincoln Laboratory participated in the FY2000 A-133 government audit and provided information and reports requested by the Defense Contract Audit Agency (DCAA) auditors throughout the year. The Controller's Office also responded to requests for information from the Department of Labor in the course of its ongoing audit of MIT's Basic Retirement Plan. The Office of Naval Research (ONR)

reviewed and approved MIT's purchasing system and master subcontracting plan through June 2004 as well as reviewing MIT's property system, for which ONR's approval remains in effect.

ADMINISTRATIVE THEMES INITIATIVES

The following sections highlight selected new and existing efforts within the Controller's Office to implement the five themes established by the Executive Vice President's Office.

Client Orientation

Through its wide range of services, the Controller's Office serves virtually everyone at MIT—faculty, students, staff, and retirees. We listen to our clients daily through a variety of formal and informal mechanisms—face-to-face, telephone, issue-oriented electronic mail lists, meetings, and the like. We disseminate information that our clients need to know using vehicles such as closing meetings, the Controller's message on the monthly financial statements, and training sessions such as the VIPcard class and the Financial Review and Control seminar. We also provide financial consulting, upon request, to departments, labs, and centers on business processes and accounting practices, and assist them with reporting issues. This year, we participated in a cross-departmental team to assist the Technology Licensing Office rewrite its intellectual property data bases, with goals of improving access to and quality of information, and to integrate financial data more closely with SAP. When resources have permitted, we have "loaned" financial staff temporarily to departments that needed assistance keeping financial operations running during a transition, such as when financial positions were open. Such arrangements provide valuable learning experiences for CAO staff, as well as supporting the overall financial operations of the Institute.

Collaboration

As a central organization that processes and consolidates MIT's financial transactions, collaboration with other units is an essential part of the Controller's Office work. The Controller's Office participates in all financial-related project teams, which last year included SAP R/3, the fund study, the student loans project, e-commerce sales, and Lincoln Laboratory property. We work with the Safety Office, the Environmental Medical Service, Risk Management, the Audit Division, and Facilities to address loss control issues. Other significant collaborative efforts in FY2001 include working with the Budget Office to develop a better structure to account for revenue; with the Treasurer's Office, Human Resources, the Benefits Office, and outside actuaries to address overfunding of the Pension Plan; and with the Environmental Programs Task Force, and departments, labs, and centers on the Green Procurement Initiative. We also worked with the Office of Cost Analysis to conduct the annual indirect cost study for the equipment and building pools, which resulted in a recovery of over $25 million.

Sustainability

Partnerships with preferred vendors for commodities and travel are part of our strategy for sustainable procurement. This year we signed a letter of intent with a new partner, Grainger, for maintenance, repair, and operating supplies. In addition, we joined with Harvard to negotiate combined contracts to purchase commodities such as bottled water and lab plasticware. The plasticware contract has been completed, and a letter of intent has been signed for bottled water. We also updated our business process documentation, where possible, streamlining processes. An enhancement to SAP, slated for availabilty in FY2002, is currently underway to permit departments to view and print scanned images of invoices from their desktop computers, eliminating the need to call accounting to obtain copies of invoices. In addition, this year we successfully converted to a new bank for MIT's VIP procurement credit card with little to no disruption to the user community.

Accountability

Responsibilities and roles are clearly defined in the Controller's Office areas. This information is published for the community on our web pages, beginning with the directory of CAO Offices at http://web.mit.edu/cao/www/offices.htm, which includes the names of supervisors of operating units. A variety of operational measurements are compiled and reviewed by the different units, and summary operational dollar and transaction volumes metrics are collected monthly. For example, the Controller's Office monitors financial commitments in SAP, reducing obsolete commitments, monitors and logs all issues sent to the accounting-issues@mit.edu electronic mail list, and reviews purchasing transactions for compliance with MIT and federal policies.

Representative Metrics

The following selection of metrics gives an idea of the volume of FY2001 transactions in various operational units in the Controller's Office. This year, old purchase order commitments in SAP were reduced to $19.1 million in June 2001 from a high of $157.2 million in December 2000. Use of the VIP procurement card grew over 30 percent from FY2000, with purchases currently averaging $1.7 million per month. During FY2001, the number of active cost objects in SAP grew 19 percent to 35,874 by year end, comprised of 4,833 cost centers, 23,678 internal orders, and 7,363 WBS elements. More than 32,000 financial transfers were done via SAP journal voucher, totaling over 333,000 individual line items. More than 18,000 items of equipment were tagged by the campus and Lincoln Laboratory Property offices.

Table 1. Volume of Payments During FY2001

	Non-PO Invoices		PO Invoices		VIP Credit Card		Travel Vouchers		Payroll Payments		Pension Payroll (excl lump sums)	
	#	$M	#	$M	#	$M	#	$M	#	$M	#	$M
Campus	67,363	$215	164,443	$585	91,252	$18	27,834	$30	268,821	$484	66,122	$100
Lincoln	--	--	78,978	$127	--	--	5,645	$2	59,998	$160	--	--
Total	67,363	$215	243,421	$712	91,252	$18	33,479	$32	328,819	$644	66,122	$100

Professionalism
MIT is the leader in e-commerce technology in higher education, with its VIPcard, partner electronic catalogs, and merchant services programs. Our staff's expertise in higher education payroll has been recognized by the American Payroll Association. Controller's Office staff make significant contributions to industry groups such as the Boston Consortium, Massco, NACUBO, the Massachusetts Higher Education Consortium, and the American Payroll Association.

More information about the Office of the Controller can be found online at http://web.mit.edu/cao/www/, http://web.mit.edu/purchasing/, http://web.mit.edu/property/www/, and http://web.mit.edu/ila/.

James L. Morgan

OFFICE OF SPONSORED PROGRAMS

The Office of Sponsored Programs' mission is to conduct the centrally organized administrative, business, and financial functions related to grant and contract administration and to assist faculty, principal investigators, and their administrators in the identification of resources for and the management of individual sponsored projects consistent both with MIT's academic and research policies and with the stewardship requirements of and obligations to external sponsors.

RESEARCH VOLUME

For FY2001 the total volume of sponsored research performed on campus was $407,423 (all numbers rounded to nearest thousand). This increase of $23.4 million represents an increase of 6.1 percent in total volume compared with the fiscal 2000 volume of $383,988. The breakdown by sponsor is shown in the table below.

Table 2. Campus Research Volume By Sponsor
(in thousands of dollars)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
FEDERAL										
DHHS	60,177	64,882	60,192	61,066	58,211	57,215	58,938	58,246	65,905	69,539
DOE	57,355	57,325	63,180	67,114	59,588	70,753	70,281	63,138	57,000	57,780
DOD	48,539	66,769	61,601	55,866	59,997	67,858	64,776	65,718	65,686	60,971
NSF	36,574	38,008	39,574	38,564	35,837	36,347	36,264	35,352	35,669	37,520
NASA	25,889	32,324	37,449	41,291	39,190	36,947	30,227	27,301	22,734	18,592
Other	9,773	8,899	8,722	9,641	8,721	7,232	9,115	7,409	6,753	6,777
Subtotal	238,307	268,206	270,718	273,542	271,544	276,352	269,601	257,164	253,747	251,179
NON-FEDERAL										
Industry	53,578	62,068	59,117	56,120	67,164	75,194	74,062	74,325	73,609	92,036
Nonprofit	24,920	25,593	23,666	26,430	25,926	28,952	36,197	42,214	50,970	55,588
Other	5,461	5,487	6,173	5,597	5,649	7,382	6,495	2,344	5,662	8,620
Subtotal	83,959	93,148	88,956	88,147	98,739	111,528	116,754	118,883	130,241	156,244
TOTAL	322,266	361,354	359,674	361,689	370,283	387,880	386,355	376,047	383,988	407,423

COMPLIANCE ISSUES

The most significant development over the past year has been the increased focus of federal agencies (particularly NIH) on the issue of compliance. In June 2000, NIH announced a requirement for education on the protection of human research subjects for all investigators who intend to submit competitive NIH applications and for a similar education requirement prior to establishing funds in the Institute's accounting system for non-competing awards. Further requirements on a far broader range of compliance subjects are anticipated during FY2002 as the federal government issues regulations on training in a wide range of research areas.

By September 2001, in a cooperative effort between the chair of the Committee on the Use of Humans as Experimental Subjects, OSP, and personnel from Information Systems, MIT will have a secure web-based training program for the use of humans as subjects that will replace the paper training course from the University of Rochester that we are currently using.

COSTING ISSUES

The Institute addressed a variety of costing issues during the past fiscal year, ranging from cost sharing and effort reporting policies and issues to negotiation of Facilities and Administrative rates for future years. Items of particular interest are described below.

COST SHARING AND EFFORT REPORTING

The Presidential Review Directive (PRD) report has identified cost sharing and effort reporting as a significant issue with respect to the research efforts of institutions of higher education. With the adoption of changes to OMB Circular A-21 in recent years and the incorporation of cost accounting standards in that document, the emphasis on accountability became, in large measure, on precision of cost accounting, not on research outcomes. The PRD report has clearly stated "The principal measure of accountability must be research outcomes" and has concluded that accountability and accounting are not the same. MIT has been active in working with federal agencies, the Federal Demonstration Partnership, and the National Science and Technology Council (NSTC) in proposing ways that accountability can be achieved with less burdensome administrative and cost accounting requirements. In January 2001 the Office of Management and Budget issued a clarification addressing student tuition and, more important, voluntary committed and uncommitted cost sharing. MIT's policies and procedures in many ways preceded the federal policy changes, and MIT will not need to make major changes to its procedures to implement the regulations.

NEGOTIATION OF FACILITIES AND ADMINISTRATIVE (F&A) AND EMPLOYEE BENEFIT RATES

MIT successfully completed negotiations with our cognizant agencies, DCAA and ONR, to establish F&A rates on a fixed with carryforward basis for FY2002 and on a provisional basis for FY2003 at 65.5 percent MTDC. Employee benefit rates were negotiated for FY2002 at rates that were substantially lower than those rates for FY2001.

OTHER COSTING ACTIVITIES

The audit conducted annually as required by OMB Circular A-133 was successfully completed in March 2001 with an unqualified opinion, no identified material weaknesses, and a determination as a low-risk entity. In addition, OSP continues to work with the Controller's Accounting Office and the Facilities Department to identify, review, and compile costs for the construction of the Stata complex in accordance with the recent changes in OMB Circular A-21.

ADMINISTRATIVE THEME INITIATIVES

Client Orientation

OSP has continued its training programs, which it offers each semester to the Institute community. These programs cover a range of general federal topics (policies and procedures, applicable circulars, F&A and EB costs) as well as a cradle-to-grave summary of how to manage a research award. In addition, it has begun regular meetings with clients to supplement the sporadic visits and presentations made in the past. Implementation of the web-based human subjects training course with its automated recording in the Warehouse of persons who have successfully completed the training will expedite the processing of NIH research proposals.

Collaboration

Many of the training courses are being taught in collaboration with personnel from academic units. In other areas, OSP personnel have worked with academic units to use SAP in new ways to track and record research activities. Personnel from academic units have served as reviewers and collaborators as the MIT electronic proposal initiative has reached rollout stage. In summer 2001 OSP will hold a series of sessions to show academic administrators how the COEUS screens can be utilized for simple but sophisticated reporting.

Sustainability

One key element for MIT is the growth in volume of its research endeavors. The metrics above show how the research enterprise has grown this past year, and its gradual growth over the past decade. OSP has developed, in conjunction with certain federal agencies, mechanisms for electronic receipt of awards (called TS 840's) and streamlined loading of the terms and conditions into COEUS. Along with this growth has come major financial and administrative compliance requirements and, primarily through the efforts of Cost Analysis, MIT has continued to integrate these requirements without disallowed costs or questioned systems.

Accountability

The move of the Research Subawards Office to OSP has been a step toward clarifying roles and responsibilities. Academic units no longer need to work both with OSP and with Procurement in the development and issuance of research subawards. The successful completion of audit reviews, F&A negotiations, and the establishment of rates underscores this.

Professionalism
OSP is a national leader in electronic research administration. We were the first institution to receive electronic awards in a standardized format from ONR, and we will be the first to be able to submit NSF FastLane proposals in an EDI format (coming in fall 2001). Participation at a senior level in policy initiatives of the federal government, authoring books and book chapters, serving on national panels, and on COGR, testify to the professionalism of the staff and their involvement in the important research administration issues being addressed across the country.

More information about this department can be found online at http://web.mit.edu/osp/www/.

Julie Norris

OPERATIONS
AUDIO VISUAL SERVICES

Audio Visual Services' central mission is to provide presentation technology support for all types of Institute activities. The fulfillment of this goal brings the department to the heart of the Institute's educational endeavors, providing daily service to faculty, students, and staff in classrooms and lecture halls. Through the use of audio, video, and computer display and amplification technologies, department staff provided service for classes, conferences, seminars, and cultural programs, totaling over 11,900 events during the past year. Total revenue for the year was more than $1,500,000, a 30 percent increase over FY2000.

Concerted efforts were made during the past year to improve levels of customer service through a more proactive, customer-based approach to processing and performing work. Customers were actively solicited for feedback through phone calls and interviews. When customers encountered problems with installed presentation technology systems, follow-up communication was provided until the problem was resolved. When services performed for customers did not meet their needs, discussions were held to understand the problems and find solutions. Working with faculty and staff from the Sloan School of Management, a user survey was developed to determine customer satisfaction. This survey will be implemented during the upcoming year and will give us an opportunity to improve levels of service. Two additional administrative staff positions were created to focus on customer service and event coordination. These positions will be filled by the beginning of the fall 2001 semester.

The department continued to actively participate in the development and installation of presentation technology systems for classrooms and meeting spaces. Working in partnership with the Registrar's Office, a full upgrade to the computer and video projection system and audio components in Room 10-250 was completed. This included additional connection points for presenters' computers and an intuitive user interface. Similar installations were completed in Rooms 34-101 and 4-364. As part of a classroom renovation project managed by Facilities, four additional classrooms were upgraded in Building 1 and include a full range of presentation technologies. New conference room installations were completed for the Chemistry and Chemical Engineering departments. The department was active in planning the renovation of Rooms 3-370 and 3-270 as part of a larger renovation of classrooms and labs in Building 3. When completed in late summer 2001, these classrooms will provide faculty and students with the latest in presentation technologies for the education of students both in the local classroom and in distance- learning environments.

Members of the department, working with a local vendor, have planned a complete renovation of the sound system in Kresge Auditorium. When completed in late summer 2001, the new system will provide for more distributed sound through the auditorium without echos or distortion. This will allow users of the hall to have more affordable sound amplification for conferences, concerts, and special events.

The increase in the number of presentation technology installations requires the department to expand its role of providing preventative maintenance of these systems. All recent classroom installations are monitored from the department's offices in Building 4. The systems are configured to communicate system status to the department maintenance group. This provides more timely service and maintenance for classrooms and will reduce costly disruptions in service. New installations will continue to employ this remote adminstration model.

In keeping with the Institute emphasis on infrastructure maintenance and development, the department has negotiated a service agreement with the Registrar's Office to maintain more than 15 classrooms and lecture halls. By expanding this service in the upcoming year, faculty and students will experience more reliable presentation technology for classes and events. Similar service agreements will be incorporated in upcoming installations.

Professional development in the department included attendance at Infocomm, the annual trade show and conference sponsored by the International Communications Industry Association (ICIA). All members of the department are members of ICIA and several are enrolled in the online training programs. Several department members enrolled in courses offered at MIT's Professional Learning Center in customer service and various computer software systems. Future educational opportunities are planned for staff to maintain and increase skills.

Development work was performed on the department's workorder database. An equipment scheduling module was created to prevent multiple booking of resources. This addition has prevented equipment shortages and resulted in

increased levels of customer service. Members of the department performed research on other university presentation technology departments to compare operating procedures, software systems, and facilities.

Further information about Audio Visual Services can be found online at http://web.mit.edu/av/.

Louis W. Graham, Jr.

CAMPUS POLICE

The MIT Campus Police continued to commit itself to providing services to the Institute through community policing partnerships that reduce crime, create a safe environment, build trust, and enhance the quality of life in the academic community. The department remains committed to delivering quality service to the community in an effective, responsive, and professional manner.

The number of crimes against persons decreased by one from 1999. The 2000 total was 33 incidents. There were 107 incidents of theft of Institute-owned property compared to 89 in 1999. Computers and computer components were, once again, the most frequent type of Institute-owned property that was stolen. There were 356 incidents of theft of personal property reported at sites other than residences, compared with 465 last year. The majority of items stolen were wallets, laptop computers, and backpacks. The number of thefts from inside residences increased to 76 in 2000 from a total of 57 in 1999. Again, the most frequently stolen items were bicycles and electronic equipment. There were 13 motor vehicle thefts this year, which is a slight decrease from the total of 15 in 1999. The theft of bicycles decreased with a total of 93 bicycles stolen as compared to 121 stolen in 1999.

Campus Police supplemented Safe Ride when its early morning operations ceased by providing 427 personal safety escorts to members of the community.

The Campus Police department also provides 24-hour emergency medical services to all members of the community as well as to Draper Laboratory and the Whitehead Institute.The total number of patients transported by the Campus Police decreased in 2000 by 41 percent from 1999. The 2000 total was 1,141.

The Rape Aggression Defense (RAD) self-defense program continued to be a popular course among the MIT community. Since the program began in 1994, a total of 580 MIT community members have been trained.

More information about this department, its services, operations, and campus crime can be found online at http://web.mit.edu/cp/www/.

John Driscoll

COPY TECHNOLOGY CENTERS

The goal of this organization is to provide the community with the highest quality copier and copier-related services. We continually strive to maintain a balance of providing new technology at reasonable costs. To achieve success, we pledge to institute creative programs of efficiency and quality controls, while maintaining sound business principles. We hold the customer at the center of our efforts and their satisfaction as our mission.

ACCOMPLISHMENTS

A major initiative in the past year was the start-up and first year operation of a new networked print-on-demand service. The July 2000 purchase of a Heidelberg/Danka 9110 digital networked printer concluded an extensive request for proposal process. The final equipment acquisition was the culmination of a two-year overhaul of our print production environment. This addition to our service completes the installation of the latest technology in the areas of electronic order production and distributed course materials. This new system will serve not only current needs but its open architecture also provides flexibility for future growth and direction. The final configuration has resulted in MIT becoming a model for other colleges and universities undergoing the difficult retooling of their print environment.

The Copy Technology Centers were pleased to continue our involvement with the Environmental Programs Task Force at MIT. Serving as a key member and consultant to related environmental issues, our department was happy to present a report in December 2000, detailing a dramatic changeover in recycled paper usage in our operations. Our department went from minimal recycled usage to a complete changeover of recycled paper. As the single largest purchaser of copy paper on campus (36 million sheets annually), the switch to recycled paper markedly affected overall MIT usage, and sent a strong signal to the community that green procurement was a vital Institute initiative.

The past year saw continued strength in the course reader service. The spring 2001 semester saw an increase of 11 percent in the number of courses offering supplemental material. A combination of experience, technology, and active communication with academic departments has allowed for more accurate print runs. In addition, the ability to scan and store electronic images enables us to print-on-demand for individual student requests. The result is a decrease in waste due to overruns and substantial savings to departments for the cost of unsold readers.

The Copy Technology Centers were active the past year in exploring and developing strategic partnerships. Internal partnerships are critical to open communication lines with MIT departments that jointly affect the quality of service to the community. External partnerships involve opportunities to remain current with the ebb and flow of technology during these unstable times. We will continue to investigate new methods of service provision. We will actively work with internal partners to enhance or introduce improved processes. Some examples of these partnerships include the following:

- The Copy Technology Center worked with a select group of MIT service providers in forming the MIT Enterprise Services under the direction of Stephen Immerman. As a member of this group, we are committed to find areas of common strengths and services to the benefit of the MIT community. By actively exploring ways of sharing resources, combining skills, and exchanging ideas, the Enterprise group has a goal to present a collective set of diverse services while following a standardized set of administrative processes. This collaborative effort will focus on integrating the member departments into a seamless provider of key services to the Institute.
- Copy Technology Centers and Mail Services combined to present a number of workshops to the MIT community this past year. Through Institute-wide workshops, as well as in small departmental presentations, the goal was to clarify the process of designing, producing, and mailing community projects. These well-attended meetings worked to eliminate confusion and problems by openly explaining the process from creation to final step. The resources of both departments were on display for customers to seek advice and practical examples. These efforts are scheduled to be continued and expanded this coming year.
- Our department worked closely with the Sloan School of Management on a distance-learning project during the past year. The process of students ordering supplemental course materials from all parts of the world was put into practice with positive results. Through a working relationship with departmental contacts, many of the problems associated with this new area of service were eliminated. The success of the program will lead to an expanded effort this year.
- A key partnership continues with Information Systems. Our department has become the hardcopy source of documentation requests integral to the Institute efforts in SAP and Athena. Interested community members can order online and receive a diverse selection of documents on SAP. Students have the opportunity to acquire paper copies of supporting Athena documentation at selected locations. By these examples, we can adjust and advance the methods of providing information to members of the MIT community.
- Members of our department played key roles in projects involving the departments of Information Systems, Procurement, Publishing Services Bureau, and Human Resources. The Procurement Department project involved an in-depth examination of copier acquisitions on campus, the results of which will lead to a new and simplified process. Information Systems called on a staff member to work on an in-depth analysis on its mainframe printing process and its future direction. The Publishing Services Bureau's project to research, design, and introduce a new MIT watermarked bond was accomplished with key advice and participation of our staff. Another staff member played a committee role in the newly introduced Rewards and Recognition initiative that is sponsored by Human Resources.
- The Copy Technology Centers cautiously explored and researched partner opportunities with outside service providers during the past year. A number of initiatives involving web submission and document management were tested and analyzed. Some turned out to be less than acceptable while others remain viable future partners. The current technology atmosphere has weeded out a number of companies and the next year will provide a better picture of the strength of those still remaining. We continue to actively seek creative partner solutions in the areas of web submission and document management. One initiative being explored involves sharing the costs of developing software solutions among partner universities. Mutual efforts between ourselves, Harvard University, and other potential schools may allow for common solutions to be developed and shared among the consortium. This effort will be examined in depth this coming year.

FUTURE GOALS

The future goals of the department will be shaped by technology and service delivery. Our industry has undergone numerous technology shifts, and adaptability is key to future success. We have put our systems in a highly flexible state through careful and well-researched acquisitions the past two years. We feel confident that our position allows for the changes that are sure to come. We will remain open to new business processes as well as actively participating in efforts to make the current ones more integrated within overall Institute planning. We will also pledge to improve on methods of service delivery. Whether dealing with a single customer or dispensing information around the world, our goal is to do it consistently, understandably, in a timely way, and with a professionalism that the MIT customer deserves. We will aggressively train our staff and use available systems to measure performance and advancement of these goals. The Copy Technology Centers maintain a pledge to provide the most efficient and cost effective services to the MIT community.

Institute Copier Program Manager, Kip Bruggeman, was cited for key involvement in two Institute projects. Marketing Manager, June Milligan, was co-recipient of the first Infinite Mile Service Award for the Enterprise Services group.

More information about this department can be found online at http://web.mit.edu/ctc/www/.

Steven M. Dimond

ENDICOTT HOUSE

For the third consecutive year, Endicott House maintained a positive cash flow position, with the department returning $240,000. Although equal to the previous year's results, the department incurred $41,000 of additional non-operating expenses. Charges include a property appraisal, legal fees for acquiring Weld Pond and administrative overhead charges. Excluding the above charges, a $281,000 cash flow would have been realized. Commitment to guest satisfaction, effective marketing programs, strong financial management, and maintenance of the physical plant were contributors to the department's achievement.

MIT bookings for FY2001 remained level with FY2000 generating a 25 percent increase in MIT revenues. Revenue increases are a reflection of marketing efforts to capture larger MIT events. Total bookings reached 467, reflecting a 7.5 percent increase over the previous fiscal year. Overall the department generated total revenues approaching $3 million. For FY2002 a 6.5 percent growth is expected with a majority coming from the MIT community.

The most important measure of the department's success is meeting the goals and expectations of our client base. Again this year, food quality, guest service, staff commitment, and operational flexibility ranked excellent. Meeting the changing and growing needs of our client base is, and will continue to be, an ongoing focus.

In order to meet the future conference and special events needs of the MIT community, expansion plans are under development. A market survey completed last fall outlines a need for additional guestrooms, increased meeting space, recreational facilities, and larger banquet space. The project will be implemented in phases over the next five to eight years. The first phase will be to upgrade and renovate the kitchen facility with construction scheduled for the winter of 2002.

Marketing efforts under contract with Conference Center Consulting Group continue to play an instrumental role in the department's financial success. A number of outreach efforts to the MIT community were undertaken, highlighted by offering shuttle service to and from campus in collaboration with MIT Parking and Transportation.

In the external arena, direct mail, and telemarketing provide the strongest yields. The external client base developed over the past four years includes meetings of upper management, sales training, senior officer, and professional associations. As with the previous three years, day meetings have made a major contribution to the overall success. Promotional activities primarily include several on-site client events, participation in three trade shows, and an exhibit at the New England Flower Show. This year's exhibit resulted in the team receiving six prestigious awards.

Reinvestment in the physical plant and property for FY2001 totaled $200,000 in accordance with our ten-year capital plan. Projects included replacement of the Main House boiler, new dining room chairs, custom bar/beverage station, public space air conditioning, barn complex carpentry and painting, laundry equipment, and a plowing vehicle. Attention was placed on reclaiming garden areas surrounding the Main House and Brooks Center resulting in four new garden areas. Additionally, grounds equipment and tools were acquired from the Coolidge Estate at no monitory cost.

Goals for FY2002 are to continue to build on our financial stability, increase usage by the MIT community, provide excellence in guest service, and enhance the facilities. These and our continued achievements reflect the dedication and commitment of the Endicott House staff.

More information about the Endicott House can be found online at http://web.mit.edu/endicott-house/.

Michael Fitzgerald

ENVIRONMENTAL PROGRAMS OFFICE AND ENVIRONMENTAL HEALTH AND SAFETY OFFICE

The Environmental Health and Safety (EHS) Office's primary responsibility is to provide EHS services to MIT's departments, laboratories, and centers (DLCs). The EHS Office supports the Institute's accountability for EHS legal compliance and positive health and safety initiatives, as well as environmental sustainability initiatives, to ensure the health and safety of the MIT community and the public and to protect the environment.

The single EHS Office was created in February 2000, when the Environmental Medical Service (including the Industrial Hygiene Office, Biosafety Office, and Radiation Protection Office), the Safety Office, and the Environmental Management Office were combined into a single EHS organization—the EHS Office. In FY2001, the EHS Office made a single telephone number available to the MIT community, 2-EHSS. This number eliminates the need for members of our community to determine whom to call for EHS service. The EHS Office also completed plans to collocate in early FY2002 in Building N52. While professionals in the EHS Office have retained their principle areas of expertise (e.g., environmental compliance, hazardous waste management, hazard assessment, and emergency preparedness and response; biosafety; industrial hygiene; radiation protection; and fire and life safety), we are shedding our separate department distinctions and broadening our base of EHS expertise to provide even better service to the MIT community. Lou DiBerardinis is directing the new EHS Office.

The EHS Office reports to the Environmental Programs Office (EPO), headed by the Managing Director for Environmental Programs. EPO oversees the EHS Office and establishes its direction and priorities. William Van Schalkwyk was promoted to a directing role within the EPO. The EPO works with the Environmental Council, the Institute Committee on EHS, and MIT's academic, research, and administrative leadership to develop EHS policy and sponsors and coordinates positive EHS initiatives among many constituents of the MIT community.

MAJOR DEVELOPMENTS

MIT Settlement of U.S. EPA and Justice Department Settlement

On April 18, 2001, MIT successfully settled a U.S. Environmental Protection Agency (EPA) and U.S. Justice Department (Justice) enforcement action resulting from a May, 1998 broad campus inspection, with MIT, EPA, and Justice signing a Consent Decree. On June 18, 2001, the Federal District Court approved the Consent Decree. EPA and Justice alleged numerous violations of the Resource Conservation and Recovery Act (RCRA, the federal hazardous waste management act), as well as violations of the Clean Water and Clean Air Acts, relating to container labeling, storage, inspection and other waste management requirements, training, monitoring and recording-keeping in research operations and at MIT's incinerator and oil storage facilities. There was no actual harm to the environment. EPA issued a letter to MIT with the Consent Decree praising MIT for its proactive response to the inspection. EPA noted that the many operational improvements as well as campus "green" initiatives which have been implemented, demonstrate MIT's commitment to environmental stewardship, and go beyond Consent Decree requirements.

The Consent Decree requires MIT to pay a $150,000 cash penalty and to undertake $405,000 of beneficial Supplemental Environmental Projects. More importantly, the Consent Decree requires MIT to make numerous improvements in its environmental operations, accountability systems, and management and organizational infrastructure, both locally in DLCs and centrally in MIT's EHS Office. EPA, Justice, and the Federal Court will oversee MIT's environmental operations, both centrally and in DLCs, until all Consent Decree Requirements are satisfied—for about five years.

MIT EHS Management System

One of the most significant Consent Decree requirements, which MIT proactively began in FY2000 and continued to pursue in FY2001, is the design and implementation of an environmental management system at MIT to more systematically manage environmental compliance, as well as toxic use reduction and environmental performance across the Institute. Commercially available management systems generally rely on central command and control, aren't designed to respect the independence of research, and won't work at MIT. To avoid EPA's usual requirement that a typical management system be implemented in nine months, MIT convinced EPA to give us more than four years to design and implement a comprehensive and integrated EHS Management System that respects the independence of research and teaching, creates better EHS accountability, and improves EHS legal compliance and good practices at MIT. (There are interim deadlines for components of the management system ranging from three months to three or four years.) By providing one approach to environmental health and safety management, DLCs will have one management system for these closely related subjects. EPA expects this MIT EHS Management System to be a model for academic research institutions. It will be implemented centrally in the EHS Office and locally in all DLCs.

The MIT EHS Management System design and implementation are being overseen by an Ad Hoc Subcommittee of the Institute Committee on EHS, co-chaired by the Vice President and Dean of Research and the Managing Director for Environmental Programs and Senior Counsel. Representatives of many DLCs, EPO, the EHS Office, and many administrative offices serve on the Subcommittee. Additional representatives of DLCs and other MIT constituencies serve on Working Committees, which are developing options and recommendations for components of the EHS Management System. These Committees, EPO, and the EHS Office will be reaching out to the broad MIT community to provide updates and receive input. The EHS Office supports this work and will be the stewards of the system once it is completed.

A discovery process to identify software needs for the system and possible solutions was completed in FY2001. The Information Systems Department led this process, which involved members of the EHS Office and some DLCs.

Supplemental Environmental Projects

MIT is undertaking three Supplemental Environmental Projects (SEPs) under the Consent Decree. The SEPs, all of which were commenced in FY2001, are an environmental education and projects program with the Cambridge Public Schools, which is being managed by the MIT Program on Environmental Education and Research as well as the EHS Office; a "Virtual Environmental Campus," a web-based environmental compliance and operations tool, which graphically depicts good practices on a typical campus; and an environmentally beneficial biofiltration stormwater management system at the Stata Center, presently under construction.

Succession in Radiation Protection Leadership

After a distinguished 40-year career at MIT, Frank Masse retired at the end of FY2001. Although Frank continues to consult to the EHS Team and to make important contributions to the radiation protection program, new leadership has succeeded his tenure as head of radiation protection programs at MIT. Mitchell Galanek assumed the role of

head of radiation protection programs on campus. Frederick McWilliams assumed the role of head of radiation protection programs at the Research Reactor. Gerald Fallon assumed this role at Bates Linear Accelerator.

ADDITIONAL SERVICE AND PROGRAM IMPROVEMENTS

Upgraded Programs

The EHS Office upgraded MIT's Occupational Safety and Health Administration (OSHA) Hazard Communication and General Safety Standards program, worked with DLCs to amend their OSHA Chemical Hygiene Plans to incorporate appropriate information on hazardous waste management under RCRA, and upgraded MIT's Department of Transportation regulatory program.

Support of Research Experiments

The Bates Radiation Protection unit of the EHS Office supported Research at Bates in FY2001, including two important experiments, the Virtual Compton Scatter and the Compton Polarimeter. This unit modeled and evaluated shielding requirements, established monitoring during experiments, and designed and evaluated interlocking requirements. The Research Reactor Radiation Protection unit supported research at the Reactor, including by providing advice on irradiation procedures, activity estimates and experimental design and protocols, and negotiating the acquisition of equipment from Brookhaven National Laboratories.

Regulatory Training

The EHS Office offered enhanced, web-based EHS regulatory training in FY2001 through a third hazardous waste management module and an enhanced chemical hygiene module. The EHS Management System will address regulatory and good practices training. Modules which can be flexibly combined to create custom training programs will maximize the relevance and minimize the time spent in training. Although core content on each subject matter will be uniform, DLCs will be able to choose delivery options (e.g., web-delivery, in-person presentations, or videotape delivery) that work best for them.

Enhanced Professionalism

Two experienced and highly qualified safety professionals assumed leadership roles in the safety unit of the EHS Office. Joe Pinciaro was promoted to the role of Deputy Director for Safety and Peter Bochnak assumed the role of Senior EHS Officer, concentrating on Safety but also on broad EHS initiatives. Under their leadership, the EHS Office worked with the Facilities Department to develop protocols for fire safety in renovation and construction projects.

Integration of EHS Consideration Capital Project Design Project

The EHS Office developed guidelines, "Best Practices for Project Managers and Designers" to assist the Capital Projects group in recognizing and addressing a full range of important EHS issues during design and construction of new and renovated buildings. This effort complements the "Green Building Initiative" summarized below. Plans for 24 major construction projects and 350 renovation projects were reviewed for EHS considerations within the context of the overall goals of the projects. The EHS Office also secured expert environmental consulting services to support capital projects at favorable rates.

Inspections

EHS inspection programs (including those for laboratory fume hoods, asbestos, and hazardous waste storage areas) were upgraded through the use of hand-held computers for some data collection. Medical surveillance of animal handlers also was converted to an electronic system to provide for more efficient and timely processing and record keeping.

Enhanced Emergency Response/Consolidated On-call System

The EHS Office worked with colleagues in other emergency prevention and response departments and the Director of Public Safety, Managing Director for Environmental Programs, and Director of Enterprise Services to systematize and upgrade MIT's overall emergency response approach.

The newly consolidated EHS Office also developed a consolidated on-call system for EHS emergency response. This system provides MIT's emergency response operations center with a single lead on-call EHS professional. The lead on-call EHS professional has four additional on-call EHS professionals as back-up, covering all EHS disciplines, seven days a week, 24 hours a day. This approach provides one point of contact for emergency responders on all EHS issues, and places the burden of delivering the appropriate scope of coordinated EHS response on the EHS Office rather than on the emergency response operations center.

EHS Cross-Training and Client Service Training

All professional EHS staff received broad EHS training to supplement their primary areas of expertise in FY 01. This broad training will allow each EHS Office member to provide more comprehensive service to DLCs, while also making better use of our staff resources and providing enhanced career opportunities to professional EHS staff.

The entire EHS Office also participated in client service training in FY01 to enhance their ability to serve the MIT community. Five principles were reinforced: professionalism, client service, teamwork, sustainable approaches, and accountability.

POSITIVE EHS INITIATIVES—"GREEN CAMPUS INITIATIVES"

In FY2001, the Environmental Programs Task Force, sponsored by the Managing Director for Environmental Programs and comprising representatives of the Facilities Department, the Campus Activities Complex, the Copy Technology Centers, the Publishing Services Bureau, the Procurement Department, Dining Services, the Executive Vice President's Office, Residential Life, and the EHS Office, led a number of campus "green" initiatives. These include MIT's recycling program, green procurement program, and food waste composting program. The Green Buildings Task Force, sponsored by the Managing Director for Environmental Programs and the Director of Facilities, with leadership by Professors Leon Glicksman and Leslie Norford and Dean of Architecture William Mitchell, and comprising representatives of MIT's Capital Building Program, Facilities Department, EHS Team and EPO, lead the development of long-term goals to reduce the campus' impact on the environment. The significant accomplishments of these Task Forces are summarized below.

Recycling

From January 2000 through December 2001, MIT's total recycling rate increased from approximately 10.5 percent to 20.3 percent. The scope of recycling was expanded from white paper only, very limited newspaper, glass, aluminum, limited plastics and yard waste, to all types of paper, cardboard, magazines and newspapers (desk-side in gray bins and in blue-topped bins in many common areas) and glass, aluminum and plastics 1-7 (in green-topped bins in many common areas), yard waste, computer equipment, metal, and wood. MIT's custodial staff, members of the Environmental Programs Task Force (EPTF), and broad participation by the MIT community were instrumental in the success of this effort. The EPTF also welcomed Recycling Liaisons representing DLCs across the Institute. The Recycling Liaisons joined in the Task Force's efforts by encouraging their colleagues to participate in recycling and other green campus programs. The Recycling Liaisons are critical to further increasing community participation.

Food Waste Composting

Dining Services and the EPTF initiated a food waste composting program in Walker Memorial and two dormitories. Over four tons of food waste per month was composted. This program is being expanded to other large dining venues on campus.

Green Goods Procurement

The Procurement Department, Copy Technology Centers, and EPTF led a green goods procurement program, focusing on the largest volume goods procured on campus—paper products. From calendar years 2000 to 2001, MIT's procurement of green or recycled products increased by 21 percent overall. The Copy Technology Centers increased the use of 30 to 50 percent recycled-content, process chlorine-free white paper from less than one percent to 100 percent. (Specialty recycled paper use increased from 10 percent to 90 percent.) The Purchasing Department, Information Systems, Athena Clusters, and a number of other departments also converted to recycled-content stocks, resulting in MIT's overall use of recycled paper reaching more than 64 percent.

Green Building Goals

The Green Building Task Force developed 10 draft long-term goals for reducing the environmental impacts of campus operations and building construction and renovation. These are energy conservation; greenhouse gas reduction; improved indoor environment; improved urban environment; increased recycling and conservation of materials; keeping total energy consumption constant even as campus facilities expand; reduced consumption of materials and resources (including office supplies, laboratory supplies, and water); reduced hazardous waste streams; reduced total campus emissions including emissions from transportation; and supporting community and regional sustainability efforts. These draft goals are being incorporated in the Facilities Department's capital project program, and are intended to be finalized in FY2002.

Stormwater Design Contest with EPA

The EHS Team designed and began implementing a stormwater management system design contest focused on solutions for residential properties, as part of EPA's Clean Charles 2005 Initiative. The overall Initiative's goal is to make the Charles River fishable and swimmable by 2005. MIT is designing the contest with EPA, and will be offering an $8,000 prize for the winning design and $10,000 for implementation.

OTHER REGULATORY INTERACTIONS

There were no formal EPA, Massachusetts Department of Environmental Protection, or OSHA inspections of MIT in FY2001.

The Massachusetts Water Resources Authority notified MIT that our utilities plant (operated by the Facilities Department) was one of only a few facilities without significant violations in 2000.

The Nuclear Regulatory Commission inspected the Research Reactor twice during the year. There were no violations. The Massachusetts Department of Public Health inspected the campus' radiation protection program under its license as well. There were no violations, and inspectors praised MIT's program.

The EHS Team worked with the Cambridge Fire Department on emergency planning procedures and conducted radiation safety, chemical and biological hazards, and air sampling training for the Fire Department's Hazardous Materials Response Team. Members of the EHS Team also participated on the Cambridge Local Emergency Planning Committee.

FACILITIES

Like the "shot heard around the world," construction can be felt all over MIT and what follows will revolutionize our environment. The major building initiative currently underway is expanding and dramatically changing the campus. When completed, it will feature five new buildings designed by the premier architects of our time. The Department of Facilities is honored to be the leader for this initiative.

In order to undertake this extensive building program, our department increased in staff from 560 to over 600. The Capital Projects group, charged with implementing the task, joins the other areas in Facilities that serve the MIT community in a variety of ways: Custodial, Design and Construction, Grounds, Mail Services, Repair and Maintenance, Recycling, and Utilities.

In addition to the building boom this year, also notable was the settlement reached by our Utilities section with NSTAR Electric over disputed costs related to the cogeneration plant dating from 1995. A payment of $1.7 million was received, representing partial refund of our Customer Transition Charge tariff payments made from 1995 to 1997.

A major focus of the Department of Facilities was the execution of its strategic goals: Improve Customer Service; Enhance and Protect MIT's Assets; Design, Build, and Deliver $800 Million in Capital Construction; Make Continuous Process Improvements; Meet MIT's Commitment to be a Model Environmental Citizen; Develop the Individual and Organizational Capability Needed for the Future. In April, members of our Operational Leadership Team joined the department's assistant directors for a session with the Executive Vice President. The purpose of the meeting was to align our efforts with the five administrative themes that he had outlined last year.

ADMINISTRATIVE THEME INITIATIVES

Client Orientation

In response to the Administrative Advisory Council's "hot button" issues, Facilities hosted a series of lunchtime forums aimed at educating customers on our services. Topics included: custodial services, recycling, energy conservation initiatives, ordering services electronically, and space planning and reconfiguration. The response to the series was so strong that additional forums will be held during the coming year.

Collaboration

Working with Controller's Accounting Office, Internal Audit, the Office of Sponsored Programs, and the Office of Budget and Financial Planning, we developed and documented a new approval process for Capital Projects. With help from Financial Systems Services, we also developed an invoice tracking system for Capital Projects that has been extended to include Design and Construction Services. These examples show how, in the past year, we have implemented new financial practices and improved existing ones in order to provide clearer, more concise, and timely information for decision makers who rely on us.

A project prioritization methodology developed by MIT's Department of Nuclear Engineering was modified for use in our Infrastructure Renewal Program. This was a collaborative effort between Professor George Apostolakis, his graduate student, Dr. Richard Weil, Dr. Dimitrios Karydas of FM Global, and Facilities' Infrastructure Renewal core team. The Facilities' core team members also collaborated with Judith Stein of Organization and Employee Development to create a project selection process.

The fourth annual report addressing infrastructure renewal, *Infrastructure Renewal at MIT: Planning, Persistence, and Improved Communication,* was published in February 2001. Fifteen million dollars was allocated this fiscal year for infrastructure renewal projects. Projects of special note include Phase II of the Residential Life Fire-Safety Systems Renewal Program and Phase II of Fire Alarm, Sprinkler, and Lab Ventilation Upgrades for Building 13.

Sustainability

As construction causes disruption on campus, we are aware of the importance of preserving green space for our community. As part of the campus beautification initiative, begun in FY2000, our Grounds Services area coordinated the development of a new garden and seating area in the inner courtyard outside Building 6. This secluded space, underutilized for many years, now provides a quiet place to relax and enjoy the outdoors.

As a result of benchmarking efforts with both educational institutions and private industry, we now know that our custodians clean 33 percent more square footage than the industry standard. This has led us to modify some custodial processes in an attempt to develop a staffing plan that could enhance the cleanliness of the campus. The plan, when approved and implemented, is expected to address many of the current cleaning issues on campus.

The department is committed to integrating environmentally responsible development practices into its building ventures. These practices propose the creation of well-designed buildings and site environments that are healthy to occupy, effectively use natural resources, and are economical and durable. To ensure their implementation, the department has rewritten its design specifications book to include these practices. The new MIT Code of Design Practice, due to be released in September, revisits all construction practices and highlights "green" technologies within each building system.

Accountability
In February, the department began collecting data from members of the MIT community on their satisfaction with our services through a customer survey. The results of that survey have given us a focus on which areas of the campus require additional attention in regard to cleaning and repair and maintenance. Also, our Design and Construction area initiated a customer survey upon completion of renovation projects. The data collected from these surveys will be useful in future remodeling and space changes.

Professionalism
We were quite proud when the International Publishing Management Association (IPMA) awarded the 2000 Mail Center of the Year honor to our MIT Mail Services. The award recognized MIT for outstanding improvements in the areas of new technology, cost savings, and processes. The IPMA Awards/Honors Committee stated that "MIT was selected as the winner because of its dramatic improvements in the overall mail operation."

Several members of our staff were presenters at conferences and symposia this year. At the Build Boston forum in November, the team working on the fire-safety improvements.

CAPITAL PROJECTS

The Capital Projects Group, established last year, has built a strong and effective construction management function necessary to handle MIT's current building program. The team consists of experienced, capable professionals, including planning, design, and construction project managers, various specialists, and administrative support staff.

During the past year, they have managed six projects under construction, 10 in the design phase, and numerous in the study phase. In addition, several milestones were accomplished, including the permitting of five major projects, two groundbreakings, and three new and significant architect selections.

A huge effort such as this building program requires that a solid reporting and tracking system be established. The seasoned members of the group were able to enact a formal decision-making structure for capital project approval and reporting procedures to maintain strong oversight and accountability. The group also developed an overall construction program budget and a schedule-tracking function with projection capability. In addition, the group wrote a procedures manual for project management, budget and schedule tools, and updated design standards.

In order to minimize disruption to the community and to keep people informed, Facilities has launched both a construction impact mitigation program and a comprehensive communications effort. In the fall, a construction web site was established and weekly updates continue to be published in *Tech Talk* and *The Tech*. This August, an expanded web site is scheduled to launch.

Work continued on the following major projects during the year:

- The Ray and Maria Stata Center for Computer, Information and Intelligence Sciences. Design development proceeded, while construction continued on the underground garage. Construction of the slurry wall was completed in October 2000. The reinforced concrete structure for the below-grade facilities should be finished by September 2001.
- Excavation began on Simmons Hall, a 10-story undergraduate dormitory on Vassar Street in October. The dormitory was designed to include space for activities to support and enhance student life. The award-winning design features 10 atria, an exercise room, study areas, a cafeteria, and a multi-purpose room. The project is on schedule for fall 2002 occupancy.
- Construction of Phase I of the Albert and Barrie Zesiger Sports and Fitness Center began in September and will complete MIT's 25-year athletic and recreation plan. This first phase includes a 50-meter Olympic pool and instructional pools with spectator seating for 500, a health and fitness area, six squash courts, a multi-activity court, administrative offices, and renovated general and team locker rooms. The schematic design is complete for Phase II of the project, which will eventually replace Rockwell Cage and provide additional athletic facilities. The project is scheduled for completion in June 2002.
- 224 Albany Street, the conversion of Building NW30 from an early 20th century mill building to efficiency apartment-style housing for 120 graduate students began in July 2000. Kitchen facilities, sleeping alcoves, and individual baths will be provided. Construction is scheduled to be completed in August 2001.
- The construction of student housing at Sidney and Pacific Street., which began in January, continues on the fast track. The steel structure is almost complete and the building, which will house approximately 700 students, will be occupied next summer.
- The installation of underground utilities at Vassar Street to support the Stata Center, Building NW30, the Zesiger Sports and Fitness Center, and Simmons Hall continues. Water mains in support of Simmons Hall are installed to the east end of the site. Chilled water, fire protection water, telephone and electric duct banks are progressing west from Steinbrenner Stadium to Audrey Street. Telephone and electric duct banks are complete to NW30 while the chilled water is scheduled to be completed this coming summer. Steam piping is installed from Massachusetts Avenue west to Building NW13 and will be placed over the roof at NW13 and NW14.
- The multi-phase renovation of the Dreyfus Chemistry Building, Building 18, continues. During this infrastructure renewal project, all labs, support, and office spaces will be renovated in vertical phases from one end of the building to the other while the building is two-thirds occupied. This project will provide a more

efficient, safe, and code-compliant layout; address energy conservation issues; and will repair and upgrade the exposed concrete skin. Expected completion is summer of 2003.

The Media Lab extension project design development continued. Master planning for the expansion to the Sloan School/School of Humanities, Arts, and Social Sciences in the East Campus began. Design development also is underway for the Vassar Streetscape project.

Architectural selections were made for the Sloan/SHASS expansion and the Brain and Cognitive Science Center (BCSC). Schematic design on the latter began in June 2001. This complex will house the McGovern Institute for Brain Research, the Department of Brain and Cognitive Sciences, and the Center for Learning and Memory, as well as space for the Division of Comparative Medicine. Program planning for BCSC began in late summer 2000.

DESIGN AND CONSTRUCTION

Design and Construction (DCS) finished the second phase of renovations to Building 45. The scope of this work essentially completes the remodeling necessary to accommodate the growing needs of the Capital Projects and Design and Construction groups. Through a co-location in Building 45, Facilities' oversight of all design and construction activities has led to improved coordination of both large-scale and small-scale construction projects.

This past year, DCS and Repair and Maintenance (R&M) created a position of Shutdown Coordinator to provide dedicated attention to the growing number of system shutdown requests required by renovations. William Homeyer, Jr., a heating and ventilation mechanic in the R&M area of our department for several years, was hired to fill this position. Because of his knowledge of the Institute and experience in Facilities, he made a very smooth transition to DCS. As a result, the position has been extremely successful and has resulted in greater control and predictability to shutdowns and has helped to minimize inconvenience to the MIT community.

Highlights of the year in the Design and Construction area included retrofitting of the Bechtel Lecture Hall, Room 1-390, with state of the art distance learning capabilities and completion of work to accommodate the Center for Learning and Memory in Buildings E17 and E18.

In addition, two classrooms were completed on the first and second floors of Building 1. These rooms feature data and power distribution. Feedback from professors regarding the new "touch screen" lighting and audio-visual controls has been very positive. These rooms reap the benefits of air handling equipment installed in the prior year's campaign. In the past, classroom renovations generally created a need for dedicated air handling units.

The William Barton Rogers building's entrance is undergoing improvements. The Information Center in Building 7 was renovated in the spring, greatly enhancing MIT's "front door." The refurbishment includes a contemporary design with a central service desk. In addition, work is currently underway to restore and clean the masonry in Lobby 7 and is anticipated to be completed in the fall.

Design and construction is ongoing for a small distance learning facility in Building 8 and a state of the art lecture hall on the third floor of Building 3, both of which will add to MIT's distance learning initiatives.

In addition to the specific projects noted above, DCS completed approximately 80 space changes of various sizes and numerous smaller interior design renovations, as well as a number of ADA-accessibility projects.

FINANCE AND ACCOUNTING

The volume of construction on campus has changed the way the department does business. We have improved our vendor selection and documentation procedure while establishing more interactive relationships with departments whose work aligns with the construction process. We also have cultivated strong working relationships with the diverse new group of planning and construction professionals now working in the capital construction area. This combination of efforts is making it possible for us to integrate financial practices while maintaining strong accountability. In addition, operation of our core business units has been enhanced to meet known needs of the Institute community as well as looking for ways to anticipate needs that have not been articulated.

Our focus on improving the quality and timeliness of information provided to clients continued in FY2001. Paying greater attention to the needs of clients has had an impact on the operation of our business units and has offered an opportunity to make changes in our financial practices. To improve reporting for client services, we first redistributed workload, streamlining the data input process. To improve visibility and encourage interaction with clients, representatives of the Facilities Finance and Accounting group attended our departmental series of customer forums. Through this venue, clients are able to have more complex conversations about processes, which results in an environment that fosters collaboration. Recently, we posted a new reporting tool on the Data Warehouse web site that allows clients easier access to internal orders. We continue to look for ways to improve our purchasing and vendor payment process, which also affect client accounts.

SAP training continues to be a major focus. This year, the Facilities Learning and Performance Team developed a class on SAP reporting that was specifically designed to meet the needs of project managers.

INFORMATION TECHNOLOGY

The Information Technology (IT) group continues to support the wide range of departmental activity. Among the outstanding issues addressed in FY2001 were SAP enhancements, a major upgrade to the Maximo work-tracking system in the Repair and Maintenance group, and unprecedented staff growth and a resulting increased demand on the time and resources of the group. Frameworks, a new system for managing the paperwork associated with construction projects, was implemented. The team continued to provide training and support for these and other applications.

Several enhanced PC and Macintosh programs have been developed for use by Facilities employees. The Maximo system was prepared for rollout to the Office of Residential Life and Student Life Programs.

The department has upgraded its local area network environment with new servers and upgraded hardware. We continue to work to address local area networking issues related to our moves to Buildings NE20 and 45.

OPERATIONAL UNITS

Efforts to keep the interiors and exteriors of our campus pleasant and appealing continued during the past year. These include replacement of drapes in E53, replacement of carpeting in the Grier Room as well as the W34 Lobby, repair and refinishing of the Barker Library floor, and indoor and outdoor garden enhancements to numerous locations.

Building Services created educational materials for our customers outlining their services and quantifying how often and what types of cleaning are done. This topic was featured at the first of our customer forum series.

A current reorganization underway in Repair and Maintenance (R&M) separates the unit into two functional areas: structural services; and mechanical, electrical, and plumbing services, with a manager dedicated to each section. The Zone operations will remain essentially as they are but will report to the Director of Operations for the next year. The Director and the two R&M managers will work closely to ensure continuous customer service and process improvement.

Through Maximo, Facilities' work order tracking system, we tabulated that 37,000 repair and maintenance work orders were completed, a nine percent increase over the previous year. In addition, through Maximo, we implemented an automatic response system so that customers are now immediately notified via email when a job has been completed.

Due to an increase in volume of special events on campus, we replaced and updated electrical supplies and equipment to better and more reliably serve the MIT community.

Administration of services at the Bates Linear Accelerator Complex in Middleton, MA is now provided by a private management firm located close to the complex but under the guidance of Department of Facilities personnel. Contracting for service has allowed us to more efficiently manage the facility and bring greater technical expertise into the complex. The distance to Middleton from the Cambridge campus has always presented a challenge in providing good facility services. Local management provides improved resources while department oversight ensures the operation is consistent with that of the main campus.

In an effort to remove recycling material more efficiently, two Grounds staff were hired to concentrate on the pickup of recyclable materials such as paper, aluminum, plastic, cardboard, CRTs, wood and metal, and transport them to a central location on the outskirts of campus. This process was developed to avoid multiple vendors' vehicles driving around campus to pick up material, adding to vehicular traffic. The new procedure also allows us to get the best price for removal.

Mail Services put a package tracking system into operation that can trace the progress of an item after it is delivered to one of the two receiving points on campus. This process, which parallels one used by UPS, will improve accountability and also provide us with metrics for quantifying how many employees handle a package during delivery.

UTILITIES

Construction of Chiller No. 6, which adds 5,000 tons of chilled water production capacity to meet the cooling needs of the new buildings, was completed. Also, Phase I of the distribution expansion in the railroad right-of-way was finished in time to coordinate with the Chiller No. 6 work and the Massachusetts Avenue storm drain project. That construction by the City of Cambridge at our front door spanned the entire year and will continue for several months. It required relocation of several MIT utility crossings and continuous coordination and communication efforts to mitigate disruption to our community.

Replacement of the large condensate tank on the roof of the plant was accomplished, as was continuing renewal of steam distribution components, high voltage electrical sectionalizing switches, domestic water piping and pumps in the main group, and lab waste piping in Building 6. A fire suppression deluge system was installed for the gas turbine, mitigating loss exposure of that very expensive asset. The control system for the East Campus Chilled

Water Plant (built in 1980) was replaced with current technology equipment with no plant outage. It will provide reliable and detailed control from the Central Utility Plant.

Water conservation improvements by reduction and reuse of water continue. A new central and automated landscape irrigation control system was installed with a weather station and central computer control of sprinkling software accounts for temperature, wind, humidity, solar radiation, and recent rainfall. To date, the system now controls irrigation of Killian Court and Briggs Field.

The department's environmental team tackled several issues this year including the implementation of a facilities inspection program that incorporates hand-held technology to record results. This new practice will shorten the time necessary to record safety concerns, including the storage of hazardous materials and the use of equipment. In addition, they led an effort with the Learning and Performance team to merge and customize environmental and safety training modules for each job type to maximize effectiveness of class time for recipients.

Exceptionally high natural gas prices through the winter significantly affected the energy budget, especially since MIT uses mostly gas for production of electricity, steam, and chilled water. Plant systems were configured to minimize energy use and facilitate switching to lower cost oil within the restrictions of our environmental permits. Also, we increased the frequency and sophistication of our gas price projections to keep senior management apprised of the magnitude of the budget overrun.

After several attempts over the past decade, a new shift schedule was implemented for the watch engineers who operate the Central Utility Plant 24/7. A backwardly rotating 8-hour shift, which was physiologically difficult, was replaced by a system devised by the union staff themselves: a combination of 12- and 8-hour shifts, non-rotating.

ADMINISTRATION

An initiative to streamline and enhance the interview and hiring processes within the department was launched. Facilities developed an internal process and electronic forms to improve communication and reduce the paperwork between our department and the Department of Human Resources. It was a successful effort that involved cooperation and understanding within our department and with Human Resources.

Members of our staff created a new hire orientation manual that will introduce new employees to Facilities as well as their specific work group and that provides overall information about the Institute. In addition, our Learning and Performance team instituted a one-day orientation program for new employees. Its purpose is to teach the basic courses including communication and customer relations and diversity. The program also includes a tour of parts of the campus.

The Learning and Performance team also is reviewing the set of internal courses currently being offered for our staff to enhance their skills and comply with both internal and external safety and code regulations. The team is expanding its computer and technical training classes as well as incorporating training on key internal procedures.

Facilities designed and implemented a plan for participation in the MIT Rewards and Recognition initiative. It consists of three levels of awards that include the Infinite Mile award ("Wonderful and Outstanding Work" Award), the Criteria Awards (to reinforce our department's strategic goals), and Director awards (overall recognition). During 2001, the following awards were given to recognize our department employees: 70 W.O.W. awards ($25 gift certificate), 10 criteria awards ($250 check), and two Director Awards ($1,000 check).

PERSONNEL CHANGES

In January, Pat Kennedy Graham joined our department as Executive Administrator. Pat's experience includes 13 years at Lincoln Laboratory as an associate group leader in the Administration Division and more than five years as managing director in the consultant services environment. In addition to handling the department's personnel issues and our learning and performance efforts, Pat will look at the department holistically in an effort to coordinate functions between the service areas.

As a result of the restructuring of Repair and Maintenance, two new manager positions were created. A manager of structural services, David McCormick, started in May. A search for a manager of mechanical, electrical, and plumbing is in progress and we anticipate hiring someone to fill the position this summer.

The chief engineer of the Central Utility Plant, Charles Studebaker, announced his plan to retire in August 2001, after 20 years at MIT. This allowed an early selection process for his replacement and several months of overlap for a smooth transition to new leadership. We were pleased to appoint Arthur May as the new chief engineer effective April 2001, as an internal promotion.

A memorial service was held at the MIT Chapel on June 28 for a dear friend of the Institute. Miles Cowen worked at the Institute for more than 30 years in the Department of Buildings and Power that later became the Phyical Plant and is now Facilities. Before his retirement in 1976, he held the position of Assistant Director for Special Services in the Plant. Among his many responsibilities were preparations for Commencement. It was well known that Miles and

his wife, Alice,would wash the flags and press them for the graduation exercises and Alumni Day. He will be missed by all who knew him.

AFFIRMATIVE ACTION

The Operational Leadership Team met with the Human Resources Diversity Group to learn more about the Institute's initiatives and to share steps Facilities takes to make our group more diverse.

More information about the Department of Facilities can be found online at http://web.mit.edu/facilities/.

Victoria V. Sirianni

PARKING AND TRANSPORTATION OFFICE

The Parking and Transportation Office (PTO) is responsible for the operations of the following:

- Parking Permit Allocation, Issuance and Management;
- Parking Facility Management for 4,814 spaces;
- Parking Violation Issuance and Management;
- Subsidized MBTA Pass Program;
- Saferide Shuttle Program; and
- TECH Shuttle

The director of Parking and Transportation provides day-to-day management of the department, and the rest of the staff are employed by Standard Parking. There are presently 30 full-time equivalent employees working under the auspices of Parking and Transportation.

The PTO is committed to providing a high level of customer service to those within the community as well to those from outside of MIT. PTO also provides effective planning to ensure the maximum usage of all parking facilities. This also includes consideration for facility placement, construction, and repairs.

MIT was awarded the 2001 City of Cambridge GoGreen Business Award in the large business transportation category. This award is given to "businesses that are leaders in promoting transportation options such as subsidizing MBTA passes, operating a shuttle bus to a nearby T stop, providing secure parking for bicycles, and allowing employees to telecommute." Jim Gascoigne of the Charles River Transportation Management Association nominated MIT for this award. The award ceremony was held on June 18th at Cambridge City Hall.

ADMINISTRATIVE THEMES INITIATIVES

The PTO is very interested in our customers' needs and concerns. In order to serve our customers more effectively, we use different methods to hear from them. We held a parking coordinators luncheon that brings together at least one employee from every department on campus to discuss parking allocations and other issues. We held a Transportation Fair to provide information on alternative commuting strategies and bicycle tips. We keep an email list so we can provide the community with messages concerning parking and transportation impacts. These are examples of the PTO's efforts on client orientation.

Collaboration was another theme that the PTO worked on this year. Efforts were made with Campus Police to develop and implement a successful abandoned bicycle removal program and a new service agreement. The PTO also worked with the new tenants of Building W92 to implement a parking and access program that would best benefit the occupants and visitors of this building.

The creation of a service agreement with Campus Police provides a sustainable platform, which will not be effected by personnel changes in either department. A service agreement with the Facilities department is being worked out presently.

One other aspect that these service agreements provide is accountability. With these documents, we will be able to recognize the responsible parties for enforcement, facility cleaning, and maintenance.

By following the above four themes professionally, we provide a valuable and well-positioned department to the Institute. The PTO will continue to investigate new technological and business process models to provide our services in a cost efficient and productive manner.

PARKING PERMIT ALLOCATION, ISSUANCE, AND MANAGEMENT

MIT is required by the Federal Clean Air Act of 1973, to provide parking to no more than 36 percent of the MIT commuting population. Due to this restriction, parking permits are not available to all who would like to have one. The total annual number of available parking permits is determined via an allocation system by the Parking Office each July. These allocations are distributed to each department for assignment. The local assignment of allocations provides a more flexible distribution system that accounts for special circumstances within that department.

There are currently 5,852 members of the MIT community with parking privileges, accounting for 7,819 stickers. There are 15 different parking permit types; 12 for employees and three for students. Parking Allocations are done

annually and take effect around September 15 of each year. All parking permits are valid from September 1st through September 15th of the following year. This means that the Parking Office issues nearly 7,000 parking stickers between August 15th and September 15th annually.

PARKING FACILITY MANAGEMENT

MIT has four parking garages and 23 open parking lots. The parking garages are the Albany Garage, the West Garage, the East Garage, and the Hayward Garage. All of the facilities have maintenance needs, including capital repair projects. The PTO coordinates these projects while maintaining a level of service needed to accommodate the Institute.

The allocation process distributes parking permits throughout all of our parking spaces on campus. For this reason, the intensity of use of each location is predetermined. In most parking locations, each space is over-allocated by a factor of .1 to .5 depending on intensity of use. The PTO must also accommodate the Institute's visitors and the occasional parking users using the same spaces. Due to the uncertainty of how many visitors and occasional users will come in each day, the lots will fill up from time to time. Overall, this approach has provided the maximum use of space possible, with minimal inconvenience to our customers.

This year we lost the Pacific Street Annex lot for construction of the new graduate student residence. We also have lost portions of the West Lot, Kresge Lot, and Albany Street Lots for construction of Simmons Hall, the Central Athletic Facility, and utility improvements respectively. In total more than 600 parking spaces have been taken out of service for construction needs.

PARKING VIOLATION ISSUANCE AND MANAGEMENT

The Campus Police as well as the PTO issue MIT motor vehicle violations on campus. There are 13 different motor vehicle violations.

Table 3. Motor Vehicle Violation Statistics

Violation Type	12 Mos. Issued	Fee
Parking Over Time Limit for Zone	435	$20.00
No Permit for this Area	9,213	$20.00
Parking in Area Not Marked for Parking	683	$20.00
Blocking Roadway, Driveway, Entrance or Crosswalk	129	$30.00
Parking in a No Parking Zone	1,031	$30.00
Parking or Driving on Sidewalk or Lawn	250	$30.00
Blocking Fire Lane or Hydrant	182	$40.00
Parking In Reserved Space	173	$40.00
Blocking Loading Zone or Dumpster	135	$50.00
Parking in Area Reserved for Handicapped	82	$50.00
Blocking Wheelchair Ramp	25	$50.00
Driving to Endanger	3	$50.00
Speeding	7	$50.00

There were 12,348 violations issued during the year ending on May 1, 2001. This was an increase of 20 percent from the year before. Most of this increase is a result of construction vehicles and activity pressures on campus parking facilities.

SUBSIDIZED MBTA PASS PROGRAM

This year MIT increased the subsidy for MBTA passes for employees and students. Previously the subsidy was $10 per pass. The new subsidy is now 50 percent of cost for over 90 percent of participants. The subsidy for a Bus pass is 62.5 percent, for Subway, Combo, Combo+, Zone 1 and Zone 2 the subsidy is 50 percent, and for Zone 3 and above the subsidy is 50 percent of the face value of a Zone 2 pass.

MIT has also relaxed the eligibility requirements for this program. We now allow residential students to participate in the subsidized program. Enrollment is now over 4,000, almost evenly split between students and employees.

SAFERIDE SHUTTLE PROGRAM

The Saferide Shuttle Program operates from 6pm to 3am, Sunday through Wednesday and from 6pm to 4am, Thursday through Saturday. There are currently five passenger vans, three of which are 12 passenger, and the other two are HP-accessible and can seat 10 passengers.

The vans operate on fixed routes each day of the year. There are two routes that serve Boston (East and West) and two routes that serve Cambridge (East and West). The last van is put into service during heavy demand or when one of the other vans is out for service.

All members of the MIT community are eligible to use the Saferide service. However, the vast majority of passengers are students going to and from their living quarters. The service times and routes are determined by the location of student residence houses.

Use of Saferide has significantly increased in the past few years. There has been considerable discussion to upgrade the service to accommodate the increased demand.

TECH SHUTTLE
The TECH Shuttle was designed to provide daytime transportation to all members of the MIT community. The route operates in a loop from Kendall Square via the T stop, to Audrey Street by the Tang and Westgate residences. The shuttle runs from 7am to 7pm Monday through Friday.

The shuttle bus is owned and operated by Paul Revere, and coordinated by the Charles River Transportation Management Association (CRTMA). The PTO works with the CRTMA to determine the schedule, routes, and headways for the shuttle. MIT provides 100 percent of the cost of this shuttle that serves 200,000 passengers per year.

More information about this department can be found online at http://web.mit.edu/parking/www/.

John M. McDonald

SENIOR COUNSEL'S OFFICE

The Senior Counsel's Office offers legal services and counseling to the MIT community on MIT matters, and also can arrange for outside legal services when needed. Our office comprises MIT's Senior Counsel, Jamie Lewis Keith, and three additional experienced counsel who joined the office in FY2001, Contract Counsel, Margaret Brill, Litigation and Risk Management Counsel, Mark DiVincenzo (who is also an experienced employment lawyer), and Environmental Counsel, Dan Winograd. We are always available as problem solvers and thinking partners. We will help MIT offices to accomplish their objectives; we strive to enable, not to prevent. We will empower areas with information so that they can balance risks and benefits, and make informed decisions. Our office's expertise includes: structuring, negotiating, and documenting major research and other collaborations and transactions (which we do with the Office of Sponsored Programs and the involved DLCs); export controls; privacy and information requests; contracts; litigation; mediation; investigations; employment and student issues; real estate and corporate law; environmental health and safety laws and permitting; and insurance and risk management issues.

The scope of clients served and matters handled by the Senior Counsel's Office in FY2001 include:

- DLCs (including the Media Laboratory) and the Office of Sponsored Programs on international research collaboration agreements and export controls;
- the Dean for Undergraduate Education and the Dean for Graduate Students on student conduct and discipline, pornography policies, affirmative action programs, contracts for services and events, employment issues, and litigation;
- Academic DLCs on employment matters, policy development, contracts, and Massachusetts and Cambridge Commissions Against Discrimination claims;
- Human Resources on a broad range of employment and benefits matters;
- The Medical Department on employment, policy, benefits, and other matters;
- The Controller's Office, Sloan Student Financial Services, and Student Financial Services on a major loan program and related contracts;
- The Facilities Department on contracts for design and construction and land-use and environmental permitting relating to a large number of new construction and renovation projects on campus;
- The Registrar's Office and DLCs on requests for student information (including "Buckley Amendment" issues);
- The Controller and Human Resources Department on tax issues, including intermediate sanctions law and policy;
- The Archives on litigation, gifts, and collections;
- Student Financial Services on debt collection;
- The Alumni Association and Events Planning Department on contracts for services and events, and dispute resolution with outside vendors;
- The Family Resource Center on proposals and contract terms for a new child care center operator;
- Lincoln Laboratory on contract and state procurement and real estate law issues;
- The Real Estate Office on real estate transactions, land-use and environmental permitting, and environmental due diligence and indemnifications;
- MIT as a "potentially responsible party" at a number of superfund sites;
- Many DLCs on legal process document handling (e.g., subpoenas and complaints);
- The Office of Disability and Residential Life and Student Life Programs on reasonable accommodations for students and employees;
- Dining Services on contracts;
- The Facilities Department on environmental consulting contracts;
- The Information Systems Department on policy, free speech, and other issues;
- The Integrated Conflict Management System Committee; and
- The Task Force on Emergency Preparedness and Response.

The Senior Counsel, working with the Director of Sponsored Programs and the Controller, represented MIT and the Media Laboratory in an initial agreement and a research and collaboration agreement with the Government of India and a new Indian company. The purpose of the undertaking is to "bridge the digital gap" and bring technology to the villages of India to support development of the social, educational, and economic infrastructure of the country and its people.

The Senior Counsel also represented MIT in its major settlement with the EPA and the Justice Department arising from a May, 1998 inspection of MIT's campus and subsequent enforcement action.

The Senior Counsel oversaw MIT's defense of a lawsuit filed by an abutter to the new student residence, Simmons Hall, on Vassar Street. The suit challenged the zoning special permit approval. She also represented MIT as legal counsel, assisting the Executive Vice President and Managing Director of Real Estate to negotiate and document a settlement agreement, which allowed the project to proceed.
The Senior Counsel's Office manages MIT's outside legal services funding. In FY2001, the Office continued an initiative with the Controller's Accounting Office begun in FY2000 to better account for and report on legal expenditures across the Institute. Legal costs can fluctuate from year to year for a number of reasons, including unanticipated litigation and other events, more or less efficient use of inside and outside counsel, and significant increases or decreases of programs. From FY2000 (the first year of the Senior Counsel's Office and of more comprehensive cost tracking), to FY2001 (when the Office gained additional experienced counsel and greater capacity to provide in-house services), the amounts paid to the largest billing outside firm were down by approximately $220,000. The amounts paid to the second largest billing firm were down $120,000. Even with an unprecedented level of real estate and other investment activity in the Treasurer's Office, resulting in an approximately $800,000 increase in legal costs for that Office, MIT's total outside legal costs increased a de minimus amount, $28,000, from FY2000 to FY2001.

RISK MANAGEMENT
The Task Force on Emergency Preparedness and Response, sponsored by the Managing Director for Risk Management/Senior Counsel and Director of Enterprise Services and comprising all MIT emergency response departments (including the EHS Office, Facilities Department, Senior Counsel's Office, Residential Life, Dean of Student Life Office, Campus Police, News Office, Medical Department, Registrar, and others) completed its work. The Task Force documented and made more systematic MIT's emergency response approach and clarified and documented the roles and responsibilities of each of the various departments in responding to five major types of emergencies. These include fires; environmental release and chemical, radioactive, or biological spills; crimes; utility disasters; floods, and other natural disasters; and severe injuries and death.

During this process, the need for an emergency response leader to coordinate the work of the different departments involved in emergency response and to be a steward of the new system, became apparent. Anne Glavin, in her new role as Director of Public Safety, assumed this lead coordinator and stewardship role.

MIT entered into a contract with the City of Cambridge under which the Fire Department will provide confined space rescue services to MIT. Some EHS Office and Facilities Department staff will be trained and will have initial and back-up response capabilities. The EHS Office will provide joint training for Fire Department and MIT confined space rescuers.

The Managing Director for Risk Management/Senior Counsel and Institute Auditor collaborated on a number of risk identification and management initiatives. The Controller and Director of Sponsored Programs also were involved. These matters included guidelines for complex transactions (including international transactions); work on intermediate sanctions issues and policies; work on controls within the EHS Management System design; and work for the Auditing Committee on their role in risk management review. MIT's Litigation and Risk Management Counsel worked with the Controller and Insurance Manager to assess risks, analyze insurance needs, and identify areas where risks may be better managed.

Jamie Lewis Keith

TREASURER OF THE CORPORATION

In FY2001, revenues and funds of $1,465.0 million were used for operations. Total operating expenses were $1,385.1 million. The results of operations were $79.9 million in fiscal 2001 in comparison to $38.3 million in the prior year.

Total net assets on June 30, 2001, were $7,855.9 million, a decrease from the $8,155.9 million reported as of June 30, 2000. This decrease was substantially the result of the market value of the investments.

In addition to the management of the investment program, the Office of the Treasurer provided assistance to the Institute's overall financial operations and planning in conjunction with the Office of the Executive Vice President.

Other activities of the Office of the Treasurer supported Institute real estate planning, community relations and the Office of Resource Development.

Allan S. Bufferd

VICE PRESIDENT AND SECRETARY OF THE CORPORATION

The Vice President and Secretary of the Corporation is responsible for relations and communications with internal and external constituencies and is the key interface between MIT's administration and trustees (the members of the MIT Corporation). The offices reporting to the Vice President and Secretary of the Corporation—working independently but collaboratively—comprise Public Relations Services: the Communications Office; Conference Services, Events, and Information Center; the News Office; the Publishing Services Bureau; and Web Communications Services. In addition, the Office of the Secretary of the Corporation supports the work of the Corporation and its committees.

PUBLIC RELATIONS SERVICES

The offices within Public Relations Services (PRS) support the mission of the Institute by enhancing public understanding of MIT and of higher education and research more generally and by supporting the community life of the Institute through communications and special events.

This year, high-profile projects drew on the talents and dedication of staff from many areas of PRS. The launch of MIT OpenCourseWare, for example, depended crucially on the skills of the News Office, Publishing Services Bureau (PSB), and Web Communications Services (WCS). As detailed in their individual reports, the three teams housed in Building E28—the Communications Office, PSB, and WCS—continue to deepen their creative collaborations.

Community continues to be an important theme for offices across PRS. That focus was recognized and strengthened in March of 2001, when the Community Services Office (formerly the Office of Special Community Services) transferred administrative reporting lines from the Campus Activities Complex to PRS. The Office, under the leadership of Ted E. Johnson, now reports to the Director of Conference Services, Events, and the Information Center. Staff from throughout PRS contributed to the Odyssey Ball during Spring Weekend, which brought together faculty, students, and staff for a special evening of music and fun.

As part of ongoing initiatives to strengthen strategic institutional communications, Patricia E. ("Patti") Richards was appointed Senior Communications Officer within PRS—a new position reporting to the Vice President and Secretary of the Corporation and to the Director of the News Office.

The monthly meetings of the Communications Operating Group and the Information Group, both convened by the Vice President and Secretary of the Corporation, continue to provide ongoing opportunities for the exchange of ideas and information on issues regarding communications and public relations.

As the academic year came to an end, the Institute's new Rewards and Recognition Program offered an opportunity to recognize the outstanding professionalism and dedication of PRS staff. Among those selected to receive Infinite Mile awards by their colleagues in the Offices of the President, Chairman, and Executive Vice President were Diane Betz Tavitian of the Community Services Office, cited for her contributions to building community at MIT, and Elizabeth Thomson of the News Office, cited for collaborative work, particularly in bringing together editors and writers from across the Institute.

Kathryn A. Willmore

COMMUNICATIONS OFFICE

The Communications Office publishes and distributes official reference information on MIT's educational, research, and administrative policies and programs in print and electronic versions. The Office strives to produce reference publications that serve consistently as benchmarks within the MIT community and model the best practice, and collaborates with PSB and WCS to support communications and publishing initiatives at MIT.

Many of the year's major accomplishments concerned the Institute's official reference publications. Among the changes to MIT's course catalogues were the publication of the *MIT Bulletin* with a cover design by Professor John Maeda, the first in the series of covers that will explore numbers series; the online publication of a preliminary version of graduate degree charts, listing degrees and fields; and initial steps in creating a content template for

departmental descriptions in preparation for moving towards a database-driven system. The Office turned mail order business over to The MIT Press, offering customers credit card transactions. The Office launched a very successful new web site devoted to MIT organization charts; these pages set criteria for inclusion of information in a variety of other campus publications. Working to develop a better working relationship with authors of the annual *Reports to the President*, the Office collaborated with the Institute Archives to refine the content template. In conjunction with Information Systems (I/S), the Office redesigned the "how to use" information in faculty and staff and student directories, conducted usability testing on the new design, and will integrate the results in the 2001–2002 directories.

This year, the director devoted three-quarters of her time to implementing the communications strategy for graduate education at MIT. The focus of this work has been an analysis of customers, the development of a coherent and consistent message strategy for internal and external audiences, and the prioritizing of business objectives. To support this commitment, Dean for Graduate Students Isaac M. Colbert provided support for additional staffing within the Communications Office.

Looking ahead, the office plans to refine its web site, migrate to a new, more flexible publishing software platform, and redesign the catalogue's page template. The office expects to continue to consult with PSB and WCS to refine goals and objectives for the Institute's key reference publications on an ongoing basis.

The presence this year of a four-person team helped broaden the scope of the office. Lori A. Weldon received a well-deserved promotion and was named Web Publications Manager. Jennifer L. Fletcher served on the PRS Rewards and Recognition committee and contributed a web site to their communications efforts, in addition to her work in shaping the business relationship with PSB's broker. In her temporary role, Diana D. Hughes has supported the office's publishing work with extraordinary flexibility and good humor.

More information on the Communications Office can be found online at http://web.mit.edu/communications/.

Barrie Gleason

CONFERENCE SERVICES, EVENTS, AND INFORMATION CENTER

The mission of the center is to meet the information needs of the MIT community, visitors to the campus, and the public; to promote a sense of community within MIT; and to support conferences and events which enhance MIT's role in the broader academic community.

Events and Information Center

The center took on a new look this year as the first stage in the restoration and enhancement of the Rogers Lobby (Lobby 7) was completed. The newly designed space within the Information Center is contemporary in appearance and far more functional, for the staff as well as the thousands of visitors who come to MIT.

As noted, the center continued to serve as an information and welcome point for visitors, as well as a central information source for members of the MIT community. Staff in the center distributed over 37,000 pamphlets, brochures, maps, guides and catalogues; answered and directed to other offices thousands of telephone and in-person inquiries; and served as a clearinghouse for mail addressed simply to MIT. Head guide for the campus tours was Melissa Edoh (Class of 2002). Terri Priest Nash trained 36 guides who conducted tours for 16,266 visitors, of whom 6,933 were prospective students, and 1,683 were international visitors. She also arranged short-term visits that brought an additional 1,061 guests to campus.

The director assisted with the logistics of the Odyssey Ball in April, a gathering of more than 1,500 students, faculty, and staff beneath a tent on Kresge Oval. Donald Ferland, Assistant to the Director, handled the arrangements for 300 recruitment presentations by companies and other organizations that visit MIT under the auspices of the Office of Career Services and Preprofessional Advising.

Commencement activities began with the Hooding Ceremony for 400 doctoral degree recipients, held in the Johnson Athletics Center on Thursday, 7 June. Chancellor Lawrence Bacow presided over this year's ceremony. The 134th Commencement Exercises were held on Friday, 8 June, and featured a well-received address by Daniel S. Goldin, Administrator of the National Aeronautics and Space Administration.

Conference Services
The Conference Services staff, led by Cathi Di Iulio Levine, manages the logistical arrangements for conferences and meetings sponsored by MIT faculty and staff. This past year, the office coordinated 42 events that brought more than 11,000 guests to campus. These events included the 25th Anniversary celebration for the Minority Introduction to Engineering, Entrepreneurship, and Science program; the NanoTechnology Conference; the Diesta Symposium; the 50th Anniversary of the School of Humanities, Arts, and Social Sciences; the Gender Equity in Academia meeting; the ILP Research Directors Annual Symposium; the Image and Meaning Conference; and Healthcare East and West.

Community Services
The Community Services Office, formerly known as the Office of Special Community Services, provides a range of important community programs, services, and volunteer opportunities to all segments of the MIT community.

The MIT Activities Committee (MITAC), with assistance and leadership from the Lincoln Laboratory Co-Convener, Karen D. Shaw and the campus Co-Convener, Regina Dugan, organized more than 126 special events for approximately 6,382 participants and sold more than 10,600 discounted tickets for cultural and recreational events to the MIT community. This represented an annual increase of nearly 2,000 participants in special events, and an increase of 50 percent in customer sales. New MITAC members this year were Mary Ann Mroz, Gayle C. Willman, and Diane R. Monahan. Frank J. Stankevicius stepped down from the committee.

The Association of MIT Retirees now boasts a paid membership of nearly 700. The Association mourned the passing of its co-founder and co-chair, Dorothy L. ("Dotty") Bowe, who succumbed to cancer on February 9, 2001. This year there were three successful over-night trips, as well as local activities. During this year, Walter L. Milne was named honorary chair. E. Jane Griffin and Joanne Miller became co-coordinators, and Sally Hansen became director of the volunteer program. The retirees are grateful for the part-time help provided by graduate intern Valerie Ristas.

Personnel
Personnel changes included the retirement of Elizabeth K. Mulcahy, Administrator of Community Services, at which time Ted E. Johnson assumed the role of Associate Director of the Information Center and Director of Community Services. Betty Jo Bolivar succeeded Pamela J. Caliskan as part-time Administrative Assistant for the MITAC program.

Gayle M. Gallagher

NEWS OFFICE
The mission of the News Office is to achieve the highest level of public interest in MIT, to publish news of interest to the MIT community and the public in a timely fashion, to monitor internal and external developments that might bring favorable or unfavorable public attention, and to be a spokesperson for MIT to the media.

The News Office finds and chronicles newsworthy stories and images about MIT and its people, assists reporters to develop their own stories, and publishes news releases as well as the MIT News web site, *MIT Tech Talk*, *MIT Research Digest*, and *MIT E-News*.

The past year saw accomplishments in many facets of the office's work:
- Following intensive discussions at two staff retreats, the Office has worked to devote more attention to the vast audience provided by the web, to provide more planning for strategic communications initiatives of the President and the individual schools and departments of MIT, and to increase collaboration with other communication offices at the Institute.
- The office has implemented a policy of publishing news of significance to the MIT community on the web in advance of the print edition of *Tech Talk*. (News releases have been issued on the web since 1994.)
- The office launched *MIT E-News*, a monthly electronic mail and web publication designed to keep alumni, parents, and others abreast of MIT news. A test launch in September of 2000 was followed by regular publication in December, under the editorship of Lisa Damtoft. The service, which currently has 900 subscribers, has been adapted by other MIT offices for their own constituencies.

- With design services from PSB, the office developed and distributed a new brochure describing what it can do for faculty and researchers.
- In March of 2001, the office moved from its long-time home on the first floor of Building 5 to handsome new space on the fourth floor of Building 11.

Much of the office's activity focused on key initiatives in teaching and research. The office worked to coordinate the announcement of MIT OpenCourseWare (OCW) on the front page of *The New York Times* —a spectacular launch for this path-breaking project to make MIT course materials freely available on the web. Over the succeeding months, OCW has continued to generate favorable comment. The Voting Technology Project, undertaken in collaboration with the California Institute of Technology, received great attention when it was announced in a coast-to-coast joint press conference utilizing new technology.

The office also worked to publicize the notable achievements of the Institute and its people. *Working Mother* magazine named MIT one of the nation's best employers for working mothers, following a nomination process in which the News Office collaborated with the Family Resource Center. Outstanding MIT accomplishments in science and engineering included the completion of the mapping of the human genome at the Whitehead Institute, the identification of genes responsible for the metastasis of cancer tumors, the use of radar technology to treat breast cancer, and the discoveries that animals have complex dreams and that seeing and imaging are the same to the brain.

The Institute's leading role in the university community was highlighted by a university presidents' conference on gender equity issues convened by President Charles M. Vest and by a symposium to mark the twenty-fifth anniversary of the establishment of the White House Office of Science and Technology Policy. President Vest received the Arthur M. Bueche Award for statesmanship in science from the National Academy of Engineering.

Keeping the community and the outside world abreast of changes within MIT, the office covered transitions in the senior leadership, including the announcement that Chancellor Lawrence S. Bacow would assume the presidency of Tufts University in the fall of 2001, to be succeeded by Associate Provost Phillip L. Clay as Chancellor. Announcement was also made of the selection of Alice P. Gast of Stanford University as MIT's next Vice President for Research, effective in the fall of 2001. During the year, Professor Nancy H. Hopkins joined the Institute's Academic Council in her role as co-chair of a new Council on Faculty Diversity. Student milestones included the award of Rhodes and Marshall scholarships and the first undergraduate exchanges under the Cambridge-MIT Institute. Notable alumni/ae achievements included the appointment of Lawrence H. Summers (Class of 1975) as President of Harvard University.

During the year, Myles P. Crowley was promoted to Operations and Financial Administrator and Lisa Damtoft was promoted to Web Developer and Editor. Denise Brehm was promoted to Editor/Writer III and Associate Editor of *Tech Talk*; she served as acting editor during Alice Waugh's maternity leave. Meghan Dufresne joined the Office as a senior editorial assistant.

More information on the News Office can be found online at http://web.mit.edu/newsoffice/www/.

Kenneth D. Campbell

PUBLISHING SERVICES BUREAU

The mission of the Publishing Services Bureau is to act as a coordinated channel for publishing activities across the Institute, applying the principles of strategic planning, technological awareness, supplier consolidation, vendor partnership, cost savings, excellence in design and editorial content, continuous learning, and customer satisfaction.

PSB continues its productive partnership with Web Communications Services. PSB/WCS coordinated over 900 jobs, from publication planning and vendor selection to design, production, and printing. Approximately $1.2 million was processed in print in fiscal year 2001, with an additional $2.1 million channeled directly to MIT/PSB interim print partners; $856,000 in creative services, of which nearly $359,000 was for web site design, was managed through PSB and WCS joint partnership.

Throughout the year, PSB worked with 17 preferred print partners, testing supplier consolidation assumptions and modeling best practice behaviors. Grid pricing was established for the production of letterhead and envelopes. PSB

and WCS have also developed partnerships with over 20 print and web design groups. The PSB procurement staff processed, facilitated, and advised on the issuance of purchase orders and contracts for $54 million in creative, print, and web services on behalf of MIT publishers.

Much of PSB's work is essentially collaborative in nature. The partnership with WCS provides "one-stop shopping" for MIT customers for coordinated print and web design and implementation. PSB has coordinated over 43 electronic publishing projects with WCS and continues to collaborate on the main MIT home page. One project of special note this year was the development of the prototype website for MIT OpenCourseWare. Ongoing projects with the Communications Office include the development of communication strategies for the Graduate Students Office and of learning opportunities for staff. In partnership with Mail Services, PSB has developed a series of templates for business reply mail that will be made available to the MIT community, offering savings in print and design costs and ensuring compliance with postal regulations.

PSB continued developing a graphic identity system for the Institute that will reflect MIT's mission and values as well as facilitate the operational handling of communications. This system will be implemented through incentives rather than mandates. A business plan for the graphic identity and a phase I design proposal for an MIT letterform logo were presented to a number of Institute constituencies for feedback. PSB collaborated with several MIT departments and offices to develop test templates for business papers. PSB continues to take on projects to design publications that will help establish equity in an identity system; clients for this project have included the Communications Office, the MIT Museum, and the News Office.

As part of the new identity system and in support of MIT's environmental initiatives, PSB investigated and designed a new and more environmentally friendly MIT watermarked bond for Institute business papers. The bond is now available in two new colors, white and natural white, and will be distributed through the Office Depot ECAT, as well as through Copy Technology Centers and PSB preferred print vendors.

Going forward, PSB remains committed to the promotion of good publishing practices and will continue to evaluate and monitor partnerships with print, design, and creative vendors. Initiatives to promote community understanding include the development of a revised web site with additional tools for Institute publishers. PSB plans to develop an on-line catalog system that will be supported by the MIT graphic identity system and will also develop an image archive, in partnership with the News Office and other Institute offices including the Archives, I/S, and the Libraries.

Print/design broker Kelly Powell left PSB in the fall of 2000; in the early spring, the office bid farewell to Ayoka Drake, senior staff assistant, and to new-media designer Christopher J. Reese. Promotions were awarded to Minerva Tirado, procurement staff member, and to Bara Blender, publishing design consultant. Both have exemplified PSB values of innovative thinking and superb customer service.

More information on PSB can be found online at http://web.mit.edu/psb/.

Monica Lee

WEB COMMUNICATIONS SERVICES

Web Communications Services publishes the official MIT web site, http://web.mit.edu/, and provides strategic consulting to MIT clients on the use of the web for communications and work processes, as well as harnessing emerging information technologies that foster organizational change within MIT. WCS continues its successful partnerships with the Publishing Services Bureau and the News Office to meet the web communications needs of MIT organizations and Institute-wide initiatives.

Together, WCS and PSB provided seamless support for MIT customers in the area of communications planning and coordinated web and print projects. In the past year, WCS and PSB jointly managed nearly $359,000 in website design contracts and developed partnerships with over 20 print and web design groups. WCS assisted MIT clients with approximately 600 web sites, with solutions ranging from planning to design, production, troubleshooting and maintenance. The team answered one-third more customer requests this year than last year—5,000 general questions about MIT and an additional 3,000 requests for web help from the MIT community. Web communications questions

involve clients' business practices and organizational structure, and WCS assisted in writing job descriptions and the hiring process for web-related positions for various clients at MIT.

One highlight of the year was the development by PSB and WCS of the prototype web site for the MIT OpenCourseWare initiative. The successful development of the prototype showed sponsors the functionality and personality of the OCW program. The site illustrated how diverse course content could be integrated into a cohesive whole with a consistent treatment and recognizable brand identity.

The official MIT web site, http://web.mit.edu/, is MIT's "front door" on the Internet, providing access to approximately one million pages. This year, the page spotlighted 269 changing headlines; the changing graphics continue to receive praise from viewers around the world. In collaboration with PSB, WCS is redesigning the MIT home page to enhance its delivery of strategic Institute messages and to make it easier for the viewer to find information.

WCS engages in broad outreach and training efforts, organizing monthly meetings of the MIT Web Publishers group and providing additional classes on specialized topics. WCS also defines guidelines for effective use of the web at MIT, including usability, graphics, and accessibility guidelines. WCS continually works to expand the depth and breadth of web-based services at MIT; projects in the past year included defining MIT's position on e-commerce and advertising on the MIT web site. The MIT Press published *The MIT Guide to Teaching Web Site Design*, by Suzana Lisanti and Deborah A. Levinson of WCS and Edward C. Barrett, Senior Lecturer in the Program in Writing and Humanistic Studies.

In the coming year, WCS will continue to enhance the quality of its services, of the MIT web site, and of its communication with the MIT community. Specific projects include the ongoing redesign of the official MIT web site; publication on the home page of feature stories accompanied by compelling graphics; work with the News Office to provide a seamless interface between the MIT home page and the News Office web site; and support for initiatives sponsored by the Council on Educational Technology.

During 2000–2001, Jagruti S. ("Jag") Patel accepted a senior project management position within I/S, and Deborah Levinson left MIT. WCS welcomed new staff members Timothy Griffin, who transferred from the I/S Help Desk, and Christopher G. Sherrill.

More information on WCS can be found online at http://web.mit.edu/webhelp/.

Suzana Lisanti

OFFICE OF THE SECRETARY OF THE CORPORATION

The Secretary of the Corporation is one of the Institute's four corporate officers, with responsibility for administering the operations of the Corporation, MIT's board of trustees, including membership and standing committees, and, through the Office of the Secretary of the Corporation, quarterly meetings of the board, and 30 Corporation visiting committees that conduct biennial reviews of the Institute's academic and research programs. The Secretary also serves as secretary of the Executive and Membership Committees, Recording Officer of the Corporation, and as joint signatory with the President in the awarding of academic degrees.

CORPORATION MEETINGS

Orientation Program and Annual Meeting

On October 5, 2000, an orientation program was held for new members of the Corporation. In the evening, new members and their spouses and guests were joined by members of the Executive, Membership, and Auditing Committees for a reception and dinner.

At the annual meeting on October 6, 2000, new members were introduced. The Corporation approved the action of the President in the awarding of September degrees, and, as part of the report of the Membership Committee, voted to approve the list of nominated members of the visiting committees and five new visiting committee chairs. Members heard reports from the President, the Treasurer, and the Vice President for Resource Development, and from the chairs of the Auditing Committee and four visiting committees: Athletics, Physical Education and Recreation; Linguistics and Philosophy; Mechanical Engineering; and the Sloan School of Management. A detailed

discussion of the Institute's long-range financial plan was led by the President and by Life Member James A. Champy, a member of the Executive Committee. Following the Corporation events, a number of Corporation members participated in the weekend celebratory festivities of the fiftieth anniversary of the School of Humanities, Arts, and Social Sciences.

December Meeting
At the meeting on December 1, 2000, the Corporation heard reports from the President and the chairs of the Membership Committee and visiting committees for the Departments of Architecture, Chemistry, Civil and Environmental Engineering, and Physics. At the conclusion of the meeting, Corporation members and their guests attended the Corporation luncheon and a festive ground-breaking ceremony for Simmons Hall, the new undergraduate residence, named in honor of Life Member Richard P. Simmons, and his wife Dorothy, for their generous contributions to the improvement of student life at MIT.

March Meeting
At the quarterly meeting on March 2, 2001, memorial Resolutions were read on the death of Life Member Emeritus Richard L. Terrell. The Corporation also heard Remarks on the transfer of Angus N. MacDonald and Kenneth H. Olsen to Life Member Emeritus and approved the action of the President in the awarding of February degrees. Reports were presented by the President and by the chairs of the Corporation Joint Advisory Committee on Institute-Wide Affairs, the Membership Committee, the Screening Committee, and three visiting committees: Biology, Economics, and Music and Theater Arts. The Vice President for Resource Development, Barbara G. Stowe, and the chair of the Campaign Steering Committee, Raymond S. Stata, presented an update on the campaign's progress. Following the meeting, members of the Corporation and their accompanying spouses and guests attended a reception and luncheon at the Faculty Club, where they were joined by new and current MacVicar Faculty Fellows and members of the family of the late Professor Margaret L. A. MacVicar, for whom the fellowships are named.

Commencement Meeting
The final quarterly meeting of the academic year was held on June 8, 2001, prior to Commencement exercises at which the speaker was Daniel S. Goldin, Administrator of the National Aeronautics and Space Administration. At the meeting, the Corporation approved the action of the President in the awarding of June degrees, approved a new master's degree program in science writing, and voted to change the bylaws with respect to the process for electing a representative from Recent Classes. The Corporation elected new Corporation members, members of the standing committees and committees of annual recurrence, chairs of the visiting committees, and members of the Corporation Development Committee. Resolutions were read to honor six members completing their terms of service on the Corporation. In addition, members heard reports from the President; from Professors Lawrence S. Bacow, outgoing chancellor, and Steven R. Lerman, completing his term as chair of the faculty; and from the chairs of the Screening Committee and the visiting committees for the Engineering Systems Division and the departments of Aeronautics and Astronautics, Electrical Engineering and Computer Science, and Ocean Engineering. Corporation members participated in the academic procession to Killian Court for Commencement exercises, for which Angus N. MacDonald served as Corporation Marshal.

CORPORATION MEMBERSHIP
Completed service effective June 30, 2001: Josephine S. Jiménez, L. Robert Johnson, Claudine B. Malone, Theresa M. Stone, R. Robert Wickham, Elliot K. Wolk.

Elected to a five-year term effective July 1, 2001: Philip M. Condit, Thomas P. Gerrity, Mark P. Gorenberg, Homayoun Hatami, Scott P. Marks, Jr., Dana G. Mead, Hyun-A C. Park, Paul Rudovsky, Marjorie M. T. Yang.

Elected Life Member effective July 1, 2001: Michael M. Koerner, DuWayne J. Peterson, Jr.

Ex officio Member for a one-year term effective July 1, 2001: L. Robert Johnson, 2001-2002 President of the Association of Alumni and Alumnae of MIT.

Ex officio Member effective April 10, 2001: Jane M. Swift, Acting Governor, Commonwealth of Massachusetts.

Transferred to Life Member Emeritus: Angus N. MacDonald (January 2001) and Kenneth H. Olsen (February 2001).

Death: Richard L. Terrell (December 4, 2000).

CORPORATION COMMITTEES

Advisory Committee on Shareholder Responsibility

The Advisory Committee on Shareholder Responsibility did not meet as a group in 2000–2001. The Treasurer monitors votes in accordance with guidelines previously established by the Committee and is charged with convening the Committee if new issues arise during the year.

Auditing Committee

Meetings of the Auditing Committee were held on October 5, 2000, and March 1 and June 4, 2001. In attendance were the Auditing Committee members, representatives from PricewaterhouseCoopers, staff from the MIT Audit Division, various MIT financial staff members, and invited members of the MIT administration.

The October meeting included a report from Treasurer Allan S. Bufferd on the FY2000 financial statements; a discussion about the management letter from PricewaterhouseCoopers; and a report from the Institute's internal auditors. The Committee accepted and approved management's recommendation to appoint the firm of PricewaterhouseCoopers as auditors for FY2001.

The March meeting included the year-end report of the MIT Audit Division, as well as the Audit Plan for 2001. PricewaterhouseCoopers presented its scope of engagement, and Julie T. Norris, Director of the Office of Sponsored Programs, gave an update on compliance to various government regulations. The Committee also received a comprehensive report on property and casualty insurance coverage for MIT.

At the June meeting, Institute Auditor Deborah L. Fisher presented a draft Auditing Committee Charter for review and comment. She noted that the draft gave due consideration to the input of Institute management, practices of peer institutions, and professional standards. Executive Vice President John R. Curry and Controller James L. Morgan presented an unaudited balance sheet and statement of operations for the Institute for the nine months ended March 31, 2001, as part of a plan to produce quarterly financial statements for the Institute.

Corporation Joint Advisory Committee on Institute-Wide Affairs

The Corporation Joint Advisory Committee on Institute-Wide Affairs (CJAC) held meetings during the year in conjunction with the meetings of the Corporation in October, December, and March. Discussions focused on the need for improved graduate advising at MIT, resulting in a survey of best practices within MIT and at peer institutions. Dinners to bring Corporation members together with students and faculty for informal conversation followed each of the CJAC meetings. The October meeting, held jointly with the Screening Committee, also focused on the process of nomination and election to the Corporation. The chair of CJAC, Theresa M. Stone, presented a report of the committee's activities to the Corporation at the March meeting.

Corporation Development Committee

Activities of the Corporation Development Committee are covered in the annual report of the Vice President for Resource Development, under the Office of Individual Giving.

Executive Committee

The Executive Committee held ten meetings during the past year. Financial issues—long-range planning, the management and enhancement of the Institute's resources, and budget processes—continued to be a major focus of activity. The Committee also devoted substantial discussion to student life and the campus community; the educational use of new information technologies and related issues in intellectual property; campus planning and the management of capital construction; new directions in research and changing patterns of research support; and current issues in financial aid and admissions.

Investment Committee

The Investment Committee held three regularly scheduled meetings during FY2001 under the chairmanship of Samuel W. Bodman. Dr. Bodman, who completed seven years as chairman of the committee on June 30, 2001, will be taking a leave of absence from the MIT Corporation and from Corporation committee work as a result of his recent appointment as Deputy Secretary of Commerce. Michael M. Koerner, a member of the Committee for ten years, was appointed chair, effective July 1, 2001.

The Wellington Management Company of Boston remained the primary investment manager and advisor for publicly traded securities, both domestic and international, an appointment that they have held for more than twenty years. The Institute continued its program, managed by four other investment management firms, of equity investments in smaller capitalization companies and through two other investment management firms of investments in international equities. The program for domestic and international alternative investments to publicly traded securities was further expanded during the past year, especially in hedge strategies in European markets. These alternative investments—including venture capital, private capital, real estate, event arbitrage, and distressed debt—are typically managed by several investment managers through pooled investment funds. A major change in the portfolio was the acquisition of Technology Square, a laboratory and office complex of more than one million square feet, contiguous to the campus, which adds significantly to the Institute's investment holdings of real estate in the Cambridge area.

Membership Committee
The Membership Committee held three meetings during the academic year to discuss matters concerning membership on the Corporation, and nominations to various Corporation standing committees and committees of annual recurrence.

Corporation Screening Committee for Nomination of Recent Graduates
The Screening Committee for Nomination of Recent Graduates, in collaboration with CJAC, held a joint dinner meeting for students on October 5, 2000, in part to explain the nomination and election process for membership on the Corporation. The committee met via three teleconferences in February 2001 to review all nominee applications. From a group of 69 candidates, the committee selected twelve for the ballot. The nomination process was conducted under the auspices of the Alumni Association using for the first time an electronic ballot over the Internet.
Mr. Homayoun Hatami (Class of 2000), received the nomination and was elected in June to serve a five-year term on the Corporation.

Corporation Visiting Committees
Fifteen Corporation Visiting Committees convened for regular two-day meetings during the academic year 2000–2001: Aeronautics and Astronautics; Architecture; Biology; Brain and Cognitive Sciences; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Economics; Electrical Engineering and Computer Science; Engineering Systems Division; Libraries; Music and Theater Arts; Ocean Engineering; Physics; and Political Science.

In 2000–2001, the Institute's 30 visiting committees were composed of 427 persons filling 550 membership positions: 63 Corporation members filled 161 slots; 203 presidential nominees filled 212 slots; and 172 alumni nominees filled 177 slots. Eleven people filled both a presidential nominee slot and an alumni nominee slot. Of these eleven, two also each filled one additional alumni slot.

Women made up 23 percent of the visiting committee membership, and minorities 15 percent. Thirty-six percent of the members were affiliated with academia, 53 percent with business and industry, seven percent with government and law, and four percent with other organizations, including non-profit enterprises.

Office Activities and Personnel
Under the direction of Susan A. Lester, Associate Secretary of the Corporation, the staff of the Corporation Office managed the quarterly meetings of the Corporation and 15 visiting committee meetings, in addition to overseeing the annual renewal of committee memberships and producing such publications as the visiting committee roster, the Corporation picture directory, and the planning guide for visiting committees. Michelle D. Hinkle continued to perform admirably in maintaining outstanding relations with members of the Corporation, while Melanie A. McCue, who joined the Corporation Office in August 2000 to handle visiting committee planning, has quickly established her effectiveness in dealing with the myriad details of carrying out the demands of the visiting committee schedule. In all of this, Susan Lester set a superb example of professional service and outstanding trustee relations.

Kathryn A. Willmore

VICE PRESIDENT FOR HUMAN RESOURCES AND EQUAL OPPORTUNITY OFFICER

As the following reports of Human Resources' leaders attest, this past year was a whirlwind of activity in the HR arena, with significant progress achieved toward our major objectives. Our broad purpose is to provide an array of programs and services that create a positive work environment and that support our leaders and employees in their efforts to achieve MIT's mission. Several new HR initiatives this past year contributed to that goal.

With broad-based organizational support, we launched the Rewards and Recognition Program for all parts of the Institute. Although the program is in its beginning stages, the early results are favorable. Several hundred employees have received "Infinite Mile" awards within their school, department, lab, or center. Well over 100 nominations have been received for the Institute-wide awards which will be presented in the fall. The anecdotes are inspiring, and MIT seems on its way to becoming a "praise-full zone."

We also kicked off the HR/Payroll project which will culminate with the installation of the SAP HR/Payroll system in the summer of 2002. An elaborate project involving stakeholders, HR and Payroll content experts, and systems professionals, key milestones have already been achieved and there are multiple teams in place working simultaneously on the redesign of all HR and Payroll processes. The first module of the new system—the Benefits module—will go live at the end of July 2001.

Thanks to the efforts of the Family Resource Center and the many internal MIT services with which it collaborates, MIT was recognized by *Working Mother Magazine* as one of the 100 best companies in America for working mothers. More accolades were received by a local parenting publication. The Council on Work and Family has also gotten underway and is planning a survey of staff this fall.

Issues of racial and cultural diversity are being addressed in many forums at MIT. Within Human Resources, a task force on staff diversity has been working under the direction of our Affirmative Action director. A report is expected this fall.

Another innovation was the creation of the Careers Planning office within Human Resources. Headed by Barbara Peacock-Coady, it instantly became a popular resource for employees seeking information on career options and development opportunities.

Responding to the organization's desire for support in recruitment of new staff, we have taken the initial steps toward creating a centralized recruitment service. A new manager for this function, David Lee, has been hired and is developing the program.

In addition to enhancing its array of educational offerings, the Organization and Employee Development staff have designed a new leadership development program called Leader to Leader, which will be kicked off this fall. They have also designed a new department head orientation process which is being greeted with enthusiasm.

Some new HR leaders have brought new capabilities to our staff. Joining us in the past year are Barbara Jablon, Director of Compensation and HR Systems, and Debra Gratto, Director of Employee Relations and Staffing. Other leadership changes include Marianne Howard's promotion to Director of HR Administration; Barbara Roberts, Manager of the Disabilities Office, taking responsbility for Workers' Compensation and hiring Sal Cortese to head that function; and Barbara Peacock-Coady's promotion to Manager of the Career Planning Office, under the direction of Margaret Ann Gray, Director of Organization and Employee Development. Marianna Pierce has just joined us as Manager of Labor Relations.
The HR staffing as of June 1, 2001, was as follows:

Of 48 administrative staff, 36 are female and 12 are male. Of these, there are five black American females, two black American males, two Asian American females, and one Asian American male. The remainder are 29 white females and nine white males.

Of 25 support staff, 19 are female and six are male. Of these, there are four black American females, one black American male, two Hispanic American females, and one Asian American female. The remainder are 12 white females and five white males.

Table 1. Staffing statistics compared with the previous year

	2000		2001	
Administrative females	68%	(30)	75%	(36)
Administrative minorities	20%	(9)	21%	(10)
Support staff females	86%	(19)	76%	(19)
Support staff minorities	41%	(9)	32%	(8)

The report of the Medical Department reflects a year of successful activity under the leadership of Dr. William Kettyle, who was appointed Medical Director last summer, and Annette Jacobs, Executive Director. The department is currently engaged in a strategic planning process that will focus its direction in the coming years.

Other significant activities have been the Medical Department's ComMITment to Care program, a comprehensive customer service initiative, its successful review by the Joint Commission on Accreditation of Healthcare Organizations, its emphasis on enhancing services for students, and its participation in the review of mental health services. The Department also implemented a new patient information system.

Laura Avakian

AFFIRMATIVE ACTION/EQUAL OPPORTUNITY AND DIVERSITY PROGRAMS OFFICE

The Director of Affirmative Action/Equal Opportunity/Diversity Programs Office functions in a variety of ways to support the Institute's departments, laboratories and centers (DLCs) in their efforts to increase and improve diversity within the Institute. The primary focus of the office's activities is to: develop strategies to promote and enhance understanding, sensitivity, and acceptance for diversity and the valuing of differences among students, staff and faculty at MIT; assist in recruitment, hiring, advancement, and retention of underrepresented minorities and women; and direct the process to develop the annual MIT Affirmative Action Plan.

The director's primary activity during the year was continued leadership of the HR Diversity Initiative Process instituted in 2000. The diverse group of administrative staff, representative of several departments across MIT, who formed the Diversity Initiative Team, continued active involvement, beyond the culmination of Phase I. The research reported in Phase I, the Interim Report, was on the best practices within and external to MIT and MIT's relative standing among its higher education peer institutions and leading corporations. The findings of the Interim Report were presented to Administrative Council. The four Phases, beyond best practices and relative standings, involved the collection of qualitative data through numerous interviews and focus groups with faculty, staff and students. These have been completed to the point of the drafting phase, which is the final report to be delivered by September 2001.
The director continued membership on the Committee for Campus Race Relations and has remained in the role of co-chair for the Education Sub-committee. The subcommittee's project this year was to collect the information and to prepare a spreadsheet listing the video programs and other media and print material available for diversity education purposes. The information included defining the subject matter, the appropriate audiences for use, and teaching notes. A section in the 2001–2002 HR Training Manual will describe this material for use by MIT members. The CCRR took leadership as the convener for diversity discussions and the AA/EEO/Diversity Office was a key resource for students during the ATO incident. The director was a discussion presenter for the ATO meetings and provided informal advisory and counseling support to students and staff. Through a CCRR initiative, diversity awareness/education will be provided for the 2001–2002 Freshman Orientation. The director is a member of the Orientation Design Team and serves as a facilitator trainer and facilitator for the planned orientation activity.

In support of MIT's minority recruitment efforts, the office has continued to provide assistance to HR and the DLCs for position openings, has expanded participation in local job fairs and special interest conferences for contact with qualified applicants, and has maintained affiliation with special-interest organizations for networking opportunities. The director will continue activity in these areas in collaboration with the HR Recruitment Manager who has recently been hired.

The office actively supported Lincoln Laboratory in its preparation to provide the documents required in response to the audit notification in April from the Office of Federal Contract Compliance (OFCCP). The AA Office's Administrative Assistant and the Director worked closely with LL staff, general counsel and an independent consultant to gather and compile the required information. The AA Office developed all reports requested and a complete AA Plan document for Lincoln Laboratory was constructed and delivered within the specified deadline. This work was immediately followed up by an accelerated effort to complete the 2000–2001 AA Plan for the entire Institute and to launch activity to produce the 2001–2002 AA Plan by year-end.

The director collaborates and consults with the Ombuds Office staff and continues to serve as a complaint handler and a resource for conflict disputes/resolution for support and administrative staff. For professional development and to support mediation needs within MIT, the director completed the thirty-six hours Mediation Course and was certified by the state as a professional mediator.

Regina Caines

BENEFITS SERVICES

We completed a comprehensive study of the current financial funding arrangements of the health and dental plans to identify potential areas of cost savings for our employees and MIT. The study, which spanned several months and involved detailed analysis of historical claims and demographic data was undertaken because of continued concerns over rising health care costs and issues raised by instability in the health care market.

At the conclusion of the study, the Benefits Office recommended the elimination of the insured Harvard Pilgrim Health Plan (HPHC), the introduction of Blue Cross and Blue Shield's Network Blue New England Plan on a self-insured basis and self-insurance of the current Tufts Health Plan.

These changes were successfully implemented during the annual benefits open enrollment in November 2000 through a series of targeted communications and information sessions. A central tenet of the campaign was our personal commitment to one-on-one counseling of employees who needed support in order to transition ongoing health care for chronically ill family members. Approximately 2,000 employees and their families were transitioned from HPHC to other health plans.
The SAP Benefits Implementation Project was a primary focus of the Benefits Office since last December. We worked closely with the Implementation Team on the benefits process redesign, the benefits blueprint, presentations to the Policy Advisory Committee, data reporting, benefits adjustments, interactive voice response and internet enrollment applications development, business process procedures documentation, testing and training. We are looking forward to using SAP as the system of record for health and welfare benefits beginning in late July 2001.

We published a revised New Hire Kit. The kit combines Human Resources policy, benefits information and other MIT services and resources into one source. Until this publication, information on these topics had been provided through separate communications that lacked a coordinated appearance.

There were several staff changes during the year. Shawn Foley was promoted to the position of Assistant Manager of Benefits Service following Marjory Magowan's departure from MIT and Sharon Clarke was promoted to Benefits Counselor assuming the position vacated by Shawn Foley. Brenda Mahon was promoted to Benefits Administrator II.

Julienne Castro

DISABILITIES SERVICES OFFICE
The Disabilities Services Office (DSO) is responsible for providing effective services and programs for students, faculty, employees, and visitors at MIT. These services include physical and communication access, academic accommodations for students, the identification and implementation of reasonable accommodations for employees. Also included is Long Term Disability and Workers' Compensation which began reporting to Human Resources as of July 1, 2000.

Over the past year, the DSO developed a functioning integrated disability management program for the Institute. All units of Disabilities Services are identified as having a role in supporting departments, employees, and Human Resource Officers regarding accommodations, leave, and attendance issues. The program would incorporate return to work and workplace accommodation initiatives, as well as, leave and attendance management strategies and when needed, transitioning the employee to Long Term Disability. The Workers' Compensation program, which provides wage replacement and medical benefit when an employee has an injury and or illness, is developing a new program structure and establishing new reporting relations with other departments.

DSO and the Department of Facilities have made great strides in the area of physical access regarding path of travel. In the area of communication access, the Institute has made three important advancements: the revision of the Access and Accommodations for Employees and Students with Disabilities located in the MIT Policies and Procedures Manual, the development of Web Accessibility, and also Software and Guidelines Policies. We have also worked with the Libraries and the ATIC Lab in identifying appropriate technology for accessible workstations and state of the art informational access.

The MIT Handbook for Students with Disabilities was finalized. This handbook has been used in training sessions with students, staff, and faculty. As a result, departments are more actively involved in providing accommodations.

The DSO continues to coordinate accessibility for students with disabilities by determining reasonable accommodations such as note-takers, scribes, extended timed exams, books on tape, and sign language interpreting.

DSO conducts ongoing presentations to the MIT community on their responsibilities to provide necessary accommodations during the hiring process; ensure that reasonable accommodations are identified when appropriate; censure that position descriptions do not impermissibly screen-out persons with disabilities; and management strategies of leave and attendance policies.
By incorporating Workers' Compensation, Susan Pritchard and Diane Sacco joined the HR organization. Susan Pritchard resigned from the position. Salvatore Cortese was hired as Assistant Manger of Disability Services.

Barbara Roberts

FAMILY RESOURCE CENTER
The Family Resource Center coordinates a number of Institute-wide work/life initiatives and provides a broad range of work/life services to faculty, staff, students, and postdocs, including assistance with child care and children's schooling, parenting concerns, family relocation, alternative work schedules, and balancing work and family. In

addition, the center spearheads and participates in a number of work/life initiatives both at the Institute and nationally, and makes available information and research on these issues.

The center managed a project to create a major new web site for the MIT community, called LifeSites. Linking over 60 human service offices and resources on campus, the site, which will go live in August, highlights and makes more accessible the range of work/life resources offered at MIT.

The center also managed communications regarding the September announcement of MIT's placement on the "100 Best Companies for Working Mothers" list, including coverage by *Working Mother* magazine and local news media, and coordinated the re-application process.

The center continued to be active in supporting MIT's child care expansion initiative. Kathy Simons coordinated the design process for the new Stata child care center; the feasibility study of renovation/expansion options at Eastgate and Westgate child care facilities; and the investigation of management options for Stata and possibly other child care programs, including a vendor RFQ and report to Chancellor Philip Clay's Child Care Committee.

Rae Simpson, together with Professor Claude Canizares, co-chairs the Council on Family and Work, which this year launched a special initiative to conduct a needs assessment of MIT faculty, staff and graduate students regarding quality of life issues. The study includes a comprehensive survey that will be distributed to all employee groups and to graduate students in the fall of 2001. Also, the council's task group on job flexibility drafted a set of guidelines on alternative work arrangements at MIT and presented its preliminary findings and recommendations to the council in May.

Working through a research center at the Harvard School of Public Health, Rae Simpson also prepared and disseminated a report entitled *Raising Teens: A Synthesis of Research and A Foundation for Action.* The report has been widely distributed to parents and human service administrators at MIT.

The center recorded a nearly 50 percent increase in client requests during the year, responding to nearly 1200 inquiries from 515 members of the MIT community (11 percent faculty, 35 percent staff, 27 percent student, 11 percent postdoc, 8 percent visiting scholar, 8 percent other). The center offered over thirty seminars and workshops on topics including adoption, job flexibility, child development, balancing work and family, multicultural family life, parenting, emergency/back-up child care, and schooling.

Sandie Woo, senior office assistant, left the center in September to attend graduate school; Delana Hirschy provided support from September through February, and Catherine Bellanti joined the center staff in February as administrative assistant. The center has always sought to maintain diversity in its staff of three, but lost minority representation through these transitions.

Kathy Simons, Rae Simpson

RETIREMENT PROGRAMS

The Benefits Office unveiled the second phase of an expanded retirement planning and investment education service. In light of the general investment climate, the menu of presentations was expanded to reflect the need for more fundamental investor education. Total attendance at presentations was 2,100.

As a result of significant developments in both the investment climate and in federal pension legislation, the Benefits Office began a comprehensive review of the retirement plans' provisions and features.

The 401(k) Plan's variable annuity purchase process was outsourced according to plans developed during 1999–2000. Contracts were negotiated with commercial annuity companies, and retirees were informed of new and improved benefits features made available as a result of outsourcing.

Phil Lima

COMPENSATION

During the latter part of fiscal year 2000, three out of four Compensation Office staff members left the Institute. All vacancies were filled by November 2000.

In fiscal year 2001, the Compensation Office participated in approximately 30 external salary surveys conducted by universities, associations, and consulting groups from across the country. The office conducted two major salary surveys, one for faculty and one for administrative staff, with approximately 22 participants each. These survey results provided us with a solid base for determining our market position and in developing our review allocation proposals to the MIT Corporation's Executive Committee.

Nine separate salary review allocations covering approximately 7,000 campus employees and faculty were administered. In an effort to streamline the review process for "Other Academics," a pilot for a quarterly review was created in collaboration with HRIS and representatives from academic areas.

Phase I of the redesign of the Classification and Compensation System for Administrative Staff was completed in February 2000 when administrative staff were converted to a new classification system consisting of six broad-banded levels. During FY2001, Phase II was rolled out and included the creation of universal guidelines meant to provide a foundation for more consistency when making pay decisions. Guideline objectives included development of common practices for administrative, SRS and support staff, promotion of regular dialogue between departments and Human Resources, and the use of generic titling and a common vocabulary. Additionally, a new job description template was created to simplify the evaluation process and provide a uniform approach.

Compensation conducted twenty-two Manager/AO Briefing sessions in which the details of the guidelines and job description template were explained. Approximately 400 managers attended. Compensation also began working with specific departments to review job content, identify appropriate titles, and review job grading as well as internal and external equity. The most notable of those was an Institute-wide initiative to review all IT salaries, with market adjustments made where appropriate.

Compensation collaborated with Budget to provide more comprehensive budget reporting during FY2001. Specifically, through data analysis, the number of active FTEs and a breakdown of interim increases and promotions were captured for quarterly reporting purposes.

In FY2000, the Defense Contract Audit Agency (DCAA) conducted a comprehensive audit of the Institute's compensation system and related internal control policies and procedures. The audit disclosed twelve deficiencies in the areas of job analysis, job evaluation, external equity, and salary structures. The Compensation Office responded to the DCAA's recommendations and has established appropriate controls and procedures, where necessary.

In addition, Compensation was involved in discussions that resulted in approximately 150 administrative position classification or reclassification requests and 130 administrative staff promotions during FY2001.

Barbara Jablon

HUMAN RESOURCES INFORMATION SYSTEMS

Human Resources Information Systems (HRIS) primary responsibility is to identify, plan, and implement human resources information system updates and/or changes to meet the strategic needs of the Human Resources Department. Managing the current Human Resources Information Systems (HRIS), includes meeting customer and user needs; implementing changes required by users, law, or benefit plans; approving security access to human resources information systems, including the data warehouse; updating and maintaining systems tables; creating and maintaining ad hoc reports; keeping up to date on developing HRIS technology; and, managing and developing the local area network. HRIS reports to the Director of Compensation and Systems.

This fiscal year HRIS continued its effort to reduce redundancy and streamline workflow. An example of this effort is reducing the number of appointment and change letters. The office is no longer producing appointment and change letters for non-stipend appointments. This reduced the number of letters generated by HRIS by several thousand. HRIS also worked closely with several of the academic departments to streamline the salary review process of "other academic" staff. With the new process departments can reappointment the other academic staff on quarterly reports. This should reduce the number of academic appointment forms created by the departments and sent to Human Resources.

The SAP HR-Payroll project went from the discovery stage to implementation stage this fiscal year. HRIS is playing a major role in this project. Kathleen Flynn is on the SAP HR/Payroll Core team full-time and is the project manager for the SAP benefits implementation. Clayton Ward and Cindy DeSimone served as team leaders on several business redesign teams. In March Cindy was assigned to the SAP Core Team project full time. Wayne Carloni and Toan Mac have provided technical and training support to the project.

Another project that was underway this fiscal year is the redesign of the HR website. Clayton Ward is leading this effort and is working with Information Systems and Publishing Services Bureau.

All computer hardware has been upgraded and conforms to MIT standards. All software has been updated from Novell to Windows NT. The upgrade from Restrac to Webhire Enterprise began this fiscal. Webhire Enterprise is a web-based application designed to provide greater flexibility and wider use of the application.

Toan Mac who terminated from HR last fiscal year has returned. We are all delighted to have him back.

Claire Paulding

REWARDS AND RECOGNITION PROGRAM

The MIT Rewards and Recognition Program was officially implemented across the Institute in January 2001, in response to the Human Resources Practices Design (HRPD) task force's findings that MIT staff perceived the Institute as a "praise-free zone." As the program becomes an integral part of MIT culture, it is meant to enhance the belief that MIT is "as excellent an employer as it is an educator." In turn, this will contribute to improved employee

morale and job performance, increased quality of customer service, improved cost savings and efficiency, and better management practices.

The program provides multiple and frequent opportunities throughout the year for MIT staff to recognize one another (both individuals and teams) for exceptional contributions to their office, their department or school, or to the Institute as a whole. Recommendations of the HRPD task force guided the creation of the program in its current form, which consists of three equally important components:

- The Infinite Mile Awards (typically providing quarterly or bi-annual recognition, customized around department's particular culture, values, and goals, and administered at the local/department level).
- The Appreciation Awards (frequent, on-the-spot "thank you's" among managers and colleagues within and outside one's own department and administered at the local/department level).
- The MIT Excellence Awards (annual recognition at an Institute-wide public celebration for exceptional contributions that align with MIT's mission, goals and values). The first annual award ceremony will be held on October 3, 2001.

A Program Administrator position was created and filled in December 2000. This has made it possible to provide assistance in the design of customized Infinite Mile and Appreciation Awards programs, the collection of data; and the creation of multiple forms of publicity, including a web site and listservs to facilitate communication and share resources among design teams and key contacts, and *Tech Talk* and *Faculty Newsletter* articles.

The Infinite Mile and Appreciation Awards
Twenty organizational groupings created and customized their own award programs. They defined specific criteria and established a nomination and selection process. All announced their awards programs via their own web sites, brochures, and/or newsletters. By June 30th, 15 had held award ceremonies. Two hundred, sixty-two MIT staff were honored for individual or team contributions in areas such as: communication and collaboration; results/outcome orientation; customer/client service; community; leadership/role model; and innovation and creativity. Recipients included individuals from administrative, support, research, and service staff.

Additionally, approximately 400 staff across the Institute received appreciation awards. These included peer-to-peer recognition, manager to employee recognition, and employee to manager recognition. The overall sentiment has been profound—enthusiasm, pride in one another's achievements, and well-attended award ceremonies.

Jacqueline Stinehart

EMPLOYMENT AND HUMAN RESOURCES SERVICES

The primary responsibility of the Employment and Human Resources Services section is to provide a full range of employee relations support to both employees and supervisors within the various organizational units. These include: conflict resolution, staffing assistance, policy interpretation, performance management and evaluation, salary administration and other HR services. This group also provides support to departments in the processing of job listings, applicant materials and employment advertising through the MIT web site, other on-line sites, and various publications.

This year the Employment and Human Resources Services area has been marked by a number of staff and organizational changes. In fall 2000, Ken Hewitt, Manager of Employment Services, took another job opportunity at MIT. This vacancy was filled by Debra Gratto. In anticipation of the development of a centralized recruitment function, one of the major initiatives highlighted on last year's report, Ms. Gratto is filling the role as Director of Staffing and Employee Relations. She is overseeing the Human Resources Officers (HRO), Human Resource Staffing Assistants (HRA), and the development of the recruitment function.

Improvement with regards to systems and processes has been a major focus this year. With the recruitment function on the horizon, an evaluation of the administrative processes and systems related to employee transactions i.e., new hires, transfers, promotions, terminations, etc. was done to determine whether or not the current infrastructure could support a quality, efficient recruitment function. Since there were numerous methods throughout the Institute for processing each particular transaction, it was determined that significant changes in processes and systems needed to occur. However, waiting for the HR/Payroll project to be complete would delay the recruitment initiative and continue to hinder the HROs and HRAs ability to deliver prompt, accurate service to their client groups. Consequently, the Employee Transaction Work Flow Team and several pilot departments, developed one method for processing many types of employee transactions across departments. It is currently being implemented throughout the Institute.

In the spirit of better customer service, the HRAs and the Human Resource Information Services (HRIS) assistants together, under the title of HRA, as a team to support the HROs. This arrangement linked HRAs more closely with a specific HRO and his/her client department. It also called for cross-training of the HRAs so that they become familiar with both the academic and non-academic sides of MIT. Current staffing includes seven HROs and seven HRAs.

A collaborative approach to work as been a major focus for HRAs and HROs alike. Working with other areas within Human Resources, Employment and HR Services, has focused on identifying inconsistencies and cumbersome processes in salary administration, disciplinary actions, and other HR practices across the institute. Once problems are identified, a process for solution is put in place. One such collaborative effort resulted in the new compensation guidelines published this year.

Other staffing changes have included Ken Hewitt's transfer to the Lab for Nuclear Science from HR, Ken Wolfe, Employment Coordinator also moved on to another role at MIT. Sue Shannon, HRO terminated her employment while Wendy Williams transferred from the HRO role to the newly established Career Services Center. Etaine Smith, Brian Chenery, and Bob Muti joined the Human Resources staff as HROs. Sarah Heany, Anita Trotta, Teresa Howell, Carol Clark were also hired in this period as Human Resource Staffing Assistants. To concentrate attention on the Recruitment function, Dave Lee was also hired as Manager of Recruitment Services.

Debra Gratto

LABOR RELATIONS

The Office of Labor Relations is responsible for negotiating and administering the collective bargaining agreements covering approximately 1,300 MIT employees in five bargaining units. Labor Relations also represents MIT in grievance arbitrations and, in some cases, before administrative agencies in employment-related cases.

On June 13, 2001, the Institute and the Research Development and Technical Employees Union (RDTEU) agreed to a new two year agreement through June 30, 2003. The wage increases in the agreement were consistent with MIT budgetary guidelines. We continue to bargain with three other groups for successor agreements to contracts that expired June 30, 2001: the Service Employees International Union (SEIU), for the Campus Bargaining Unit; the SEIU for the Lincoln Laboratory Bargaining Unit; and the Security Officers Independent Union (SOIU). The current agreements with all three groups have been extended while we are still in negotiations.
The number of grievances reported to the Office of Labor Relations in 2000 rose slightly from the previous year, from 49 to 57. Two arbitration cases were decided, with the arbitrator ruling in favor of the Institute in both. Two cases filed to arbitration were resolved and three withdrawn before the arbitration hearing. Three grievances have been filed to arbitration and have yet to be heard.

During 2000, six cases were filed before the National Labor Relations Board. Of the cases that came before the board in this period three were withdrawn, two were dismissed in full, and one dismissed in part. Currently, there is one case still under consideration before the Board.

In addition this office provided advice and counsel to departments, laboratories, and centers on issues that involve union relations, collective bargaining, employment litigation and employment policy.

David Achenbach

ORGANIZATION AND EMPLOYEE DEVELOPMENT

Performance Consulting and Training reorganized in both structure and responsibilities to become Organization and Employee Development (OED). This name reflects the new mission of this function: to advance the organizational effectiveness of MIT and its departments and to promote the professional development of MIT staff. To accomplish this mission, OED provides four major client-focused services: organization development consulting, career consulting, professional development courses, and the management of the MIT Professional Learning Center.

Organization Development Services
Over the past year, the organization development (OD) consultants provided internal consulting services for approximately 150 projects for MIT and its departments, labs, and centers. In these projects the OD consultants collaborated with clients to provide services in managing change, developing teams and leaders, and planning and facilitating meetings and retreats.

Examples of internal consulting projects include:

HR-Payroll Project (SAP)
- Designing and implementing a methodology for change management
- Serving in linkage and clearinghouse roles for the project's various segments
- Contributing as part of the communications team
- Coordinating and facilitating the process redesign teams

Working Group on Support Staff Issues
- Serving as a resource to the co-conveners and task group leaders
- Planning and leading the group's year-end event
- Leading courses in the Working Group's luncheon series

Dean for Undergraduate Education
- Planning and facilitating its strategic planning process

Environmental Programs and Risk Management/Senior Council
- Helping plan Emergency Response training
- Planning and facilitating various meetings and retreats
- Providing coaching in conjunction with projects
- Leading workshops on client service
- Department of Facilities
- Planning and facilitating the process for the work of the Infrastructure Renewal Team.
- Collaborating with others in Facilities to provide performance feedback training for union staff and coaches.

Diversity Initiatives
- Facilitating work throughout the phases of the HR-sponsored diversity initiative team.
- Helping plan a diversity program for Freshman Orientation

Rewards and Recognition
- Creating and implementing a communications plan
- Designing and facilitating implementation meetings
- Assisting in the job description and search for the program's coordinator

Graduate Students Office
- Planning and delivering workshops on collaboration sponsored by GSO leadership
- Consulting on a leadership development program for graduate students

Dean of Student Life
- Leading workshops on the Myers-Briggs Type Indicator
- Serving as facilitator for Leadershape

Professional Development Programs
OED's second area of responsibility is professional development. OED held 118 courses through its open enrollment program. A total of 1033 MIT employees attended these courses. New courses included Everyday Praise for Everyday Results, Preparing for and Giving Presentations, Tips and Techniques for Time Management, Transitioning to Management, and Understanding Workplace Culture and Change.

OED also provided consulting about course development to content experts within the Institute. This includes consulting on the new financial management courses offered through its open enrollment program. OED also provided train-the-trainer programs for courses on financial management, project management, and mastering meetings.

OED doubled the number of fee-for-service courses it offered to the Boston Consortium from 10 to 20. In addition, a new service was offering OED courses to Boston-area alumni/ae.

In addition, OED laid the groundwork for an extensive leadership development initiative to be implemented soon.

Center for Career Planning at MIT
OED's third area of responsibility is Career Planning at MIT, which opened its doors in January 2001. A multi-service career center, it provides career-planning services to all of MIT's employees and their organizations. Services are specifically designed to support MIT's commitment to help employees assume responsibility for their own successful development as well as linking that development to the strategic direction of the organizations in which they work.

In the first six months of operation (January 2001–July 2001) services were developed and delivered to approximately 400 employees and more than 10 departments, labs and centers (DLCs). These include:
- Brown bag series on job search skills
- Career workshops and courses
- Customized career programs for specific departmental groups
- Developmental advising program
- Fee-for-service courses to member schools within the Boston Consortium
- Individual career coaching/consulting to members of the MIT support staff, administrative staff, sponsored research staff and faculty
- Informational interviewing network
- Partnerships with DLC's to implement career development strategies
- Resource lending library
- Targeted promotion of Tuition Assistance benefits

Employees utilize these services to enhance their careers by exploring new career directions, identifying developmental opportunities, implementing career change, and/or finding new positions.

Departments, labs, and centers utilize these services to link strategic planning needs to workforce planning. This includes assessing skills and competencies and identifying development strategies to meet future needs.

Learning Environment Services
OED's fourth area of responsibility is led by its Learning Environment Team. This team manages the MIT Professional Learning Center (W89). The mission of the center is to provide a quiet, clean, and pleasant environment to support effective training based on trainer and/or customer needs. It has six state-of-the-art computer-training rooms and two professional development/meeting rooms.

Since its inception in 1996, utilization and demand for services have increased. Utilization was 74 percent for the professional development rooms and 46 percent for the technical-training rooms. FY2001 yielded a total increase of nine percent in utilization over the previous year.

This year OED collaborated with Information Systems in bringing a Technical Coordinator on board to support customers' growing demand for customized hardware configurations. This new role also oversees all computer maintenance, coordinates changes and upgrades to remain current with the latest MIT-supported software, and supports technology-related initiatives.

The Learning Environment Team supports the various performance development courses, the overall work of OED, and the groups/individuals in the MIT community utilizing its services.

Margaret Ann Gray

MIT MEDICAL

Meeting the medical needs of the MIT community by providing high quality medical care and health education with low barriers and easy accessibility remain the major focus of the operation of the Medical Department. The vast majority of the care needs of students, employees and Health Plan members are met within the Cambridge based facility or at the health facility at Lincoln Laboratory in Lexington. In addition, several members of the department maintain active clinical and academic relationships with local area hospitals and the Harvard Medical School. These relationships help ensure outstanding care for our patient who need hospital based or other specialized care.

Several important accomplishments and continuing initiatives have marked this past year.

Strategic planning activities continued during the year. The pace of this process has increased significantly and a report is expected in the early fall of 2001. The previous strategic planning project ended about five years ago; many of the identified projects have been completed. The current planning process has so far reaffirmed the mission and values of the department. An extensive data gathering process—both internally and externally—is underway which should inform and help shape the future directions of the department. This process is being conducted with help from two consultants and with broad representation from within the department and from the community that we serve. The process will provide us with a vision for the future. Goals will be established and implementation plans will be designed that will support the vision for our future.

The ComMITment to Care (C to C) program, our customer service initiative, continues to provide a systematic mechanism to improve our services. The process involves identifying areas of need, designing and implementing approaches to the issues and measuring progress. Work continues on mechanisms that allow C to C values and imperatives to be reflected in the performance reviews of members of the Medical Department.

In October of 2000 the Medical Department was the object of an unannounced survey by the Joint Commission on Accreditation of Healthcare Organizations. Surprise visits are now part of the JCAHO's repertoire of evaluative services that help ensure consistent adherence to standards of excellence in patient care, administration and maintenance of a safe, effective facility for the delivery of care. The unannounced survey resulted in one "type one" recommendation—an administrative issue not directly related to patient care. This has been corrected to the satisfaction of the Commission.

The MIT Medical/Lexington facility continues to provide care for employees at Lincoln Laboratory and other eligible individuals. This site provides an off campus venue in the western suburbs that is available to all those who are eligible for care by the MIT Medical Department.

Dr. William M. Kettyle replaced Dr. Arnold N. Weinberg as Medical Director in August of 2000. With the support of the entire department the transition has been relatively smooth. Several management retreats were held during the year that has led to the development of some new administrative initiatives.

Shifting administrative responsibilities closer to the points of care should help improve service across the department. The service chiefs will play increasing roles in the hiring of personnel, making decisions about compensation and work expectations and in developing a system of clinician evaluation. Infrastructure support for these changes is under development.

A new position, Clinical Director for Campus Life, was created in a fashion analogous to the structural changes underway in the office of the Dean for Student Life, a new position has been created that is intended to foster enhanced connectivity between students and the Medical Department. Working more closely with other helping services on campus—dean's office, housemasters, campus police, etc.—the occupant of this position will be able to continually assess the medical and health education needs of the student community and be able to connect resources with need.

At the close of this academic year the report of the Task Force on Mental Health was being generated. In draft form the report of this widely representative group called for some specific changes in the provision of mental health services and for greater out-reach and support for the community in the realm of mental health issues. Initiatives to meet some of the suggestions of the Task Force are already in development and the Medical Department will actively participate in analyzing prioritizing and implementing needed changes.

Further progress has been made on implementation of information management systems. This process should improve scheduling, clinical results reporting and resource utilization. For those computer comfortable clinicians, a virtual electronic medical record is evolving.

A patient satisfaction surveying process has begun. Using a mailed in instrument randomly selected patients are asked to rate their recent visit from several points of view. Although the process is still very new, it should allow us to identify areas in need of improvement and also to identify best practices in areas in which our performance is high.

MEDICAL CARE ACTIVITIES

Dental Service, Jay Afrow, D.M.D., M. H. A., Chief

During the past year the MIT Dental Service has undergone a significant transition and upgrading of its facilities. We have added two new general dentists and one hygienist to our staff. These individuals have allowed the MIT Dental Service to increase its ability to provide care to more members of the community. Recently the service renovated its waiting area and is in the process of upgrading the sterilization area to meet current JCAHO requirements. The X-ray equipment and film have been replaced with low exposure radiographic technology. This allows us to provide high quality dental X-rays with 67 percent less radiation exposure compared to the previous equipment. Air abrasion technology has also been added. This technology allows the treatment of small cavities without drilling.

The MIT Dental Service has worked to be more active and visible in the MIT community. Lectures on dental issues have been offered as part of the IAP program, at Lincoln Laboratory, and at departmental meetings. A program has been developed in conjunction with the MIT Pediatric Service to provide dental care to handicapped children who have been unsuccessful obtaining care in the general community. As the reputation and visibility of the MIT Dental Service continues to grow, so does the patient demand for services.

Medical Service, David V. Diamond, M. D., Chief

Personnel changes included the appointment of a new Chief of Medicine, the departure of a long-term staff member, and the arrival of a new Primary Care Physician. Our clinical management system continues to evolve toward a full electronic medical record with the addition of on-line clinical notes and radiology reports.

Visit rate overall was stable, but more patients are taking advantage of our Lexington clinic site which is now in it's second year of operation. Members of the department continue their involvement in various Institute committees such as COUHES, Committee on Biosafety, Animal Care Committee, and Ergonomic Committee. The Practice Management Team, organized as a result of recommendations of our on-going ComMITment to Care program, has addressed operational issues, including appointment availability, patient communications, staffing levels, and continues to coordinate innovations in patient centered services.

Health Education Service,
Gina Baral, MPH, LCSW, Health Educator for Students, Health Education Service
Marlisa Febbriello, MPH, Health Educator, Health Education Service

Health Education at MIT Medical remains committed to serving the needs of the MIT community through effective programming, education, and outreach. The professional health educators continually strive to reach students and other members of the MIT community and MIT Health Plan with information and active health promoting programs. New initiatives in student health education have included collaborative programs such as Residence-Based Advising, MedLIBRARYs in the FSILGs, and the campus-wide "Relationship, Responsibility, and Respect Week"; expanded activity during Orientation, including the Wellness Fair and GRT training; outreach activity, including the Student-Medical Mixer and residential programming; increased MedLINK activity, including additional group programming requirements and mandatory continuing education sessions and participation on

Institute committees such as the Campus Alcohol Advisory Board, the Alcohol Education Working Group, and the Mental Health Task Force. MedSTOP, in the Student Center, continues to be a popular spot where pamphlets on relationships, mental health and stress, sexual health, drugs, sexual identity and other topics are available. The MedLINK program now includes 106 individuals who serve in 26 living groups (all undergraduate residence halls, one graduate dorm, and 15 FSILGs). Logs are being kept to monitor interactions among students and MedLINKS.

Health Education efforts at the MIT community level have also continued to grow. Collaboration with the MIT Family Resource Center has led to increased participation rates in programs, and widened the variety of services available to parents and parents-to-be. New classes and class times have been added to meet the needs of the community. Employees, students, MIT Health Plan members, and retirees attended classes throughout the year. Wellness classes (49 classes with a total of 511 participants) were held in both Cambridge and Lexington. 125 childbirth and parenting classes were offered in Cambridge. A total of 745 parents and parents-to-be attended these classes. During IAP 2001, 47 health-related talks were presented to 1150 participants.

The service continues to serve its twofold mission of education to both the student population and the overall MIT community.

After Hours Service, Howard M. Heller, M.D
In order to provide 24 hour a day, seven days a week care year round, a staff of physicians has been assembled. These individuals are all licensed physicians and most are fully trained in Internal Medicine or Pediatrics. Many are receiving advanced, sub-specialty training at local area hospitals. In addition, a dedicated staff of Nurse Clinicians provides urgent care services.

Inpatient Medical Services, William A. Ruth, M. D.
The 18-bed JCAHO accredited hospital facility located in Building E23 continues to provide sub-acute level care for members of the MIT community. In addition to management of acute, non-life threatening, illnesses, like gastroenteritis and viral syndromes, this facility also provides post-operative care for patients under going orthopedic, gynecologic and general surgical procedures. Increasingly, the unit is called on to provide end of life services for members of the MIT Community.

Admissions during the year totaled 560. Students accounted for 157 (28 percent) and Medicare eligible patients comprised 146 (26 percent) of the admissions. The remainder were Health Plan members. In addition there were 71 transient—short stay (< 6 hours)—admissions for patients undergoing diagnostic testing or treatment.

Obstetrics and Gynecology Service, Lori A. Wroble, M.D., Chief
Four full-time and one part-time physician, together with two nurse clinicians provide OB/GYN care of the MIT community.

Table 2. Statistics for July 1, 1999—June 30, 2000

Patient Visits	8,722
Patients Seen	3,676
Obstetrical Services:	
Deliveries	171
Cesarean Section Rate	18%
Primary	13%
Secondary	5%
GYN Surgeries	59
Major	19
Minor	30
Missed Ab	10

Dr. Delli-Bovi, a part-time provider at MIT for 20 years, left as of June 30, 2001. We are now close to the end of a search for a replacement. Dr. Liau and Dr. Wroble closed their practices to new GYN patients in an attempt to decrease the wait time for appointments. All our practitioners continue to participate in community activities, including IAP lectures, pre-med advising, MEDLINKS advising, participating in the HST Program's introduction to clinical medicine, Harvard Medical School Primary Care Mentorship Program, precepting MGH Nurse Practitioner students and supervising residents at the Brigham and Women's GYN Clinic. Our providers also participate actively on departmental committees and initiatives as well as various Brigham and Women's Hospital committees.

Pediatrics, Mark A. Goldstein, M.D., Chief
A continuous quality care improvement project focused on asthma care for pediatric patients has been successfully implemented. Although asthma is a frequent diagnosis for MIT pediatric patients, this project is designed to reduce hospitalization for asthma. A similar program is being developed to guide the care of jaundiced newborns.

Local, regional and national efforts were made to educate our patients and other professionals about issues of importance in medical care. Staff participated in IAP, developed programs for the Massachusetts Medical Society and presented a program at the Society for Adolescent Medicine on issues important to teens. Dr. Goldstein is

coauthor of *Controversies in the Practice of Medicine*, a book that describes a number of issues important in current medical practice and aimed at an adolescent readership.

Student Health, Mark A. Goldstein, M.D., Chief
The Medical Department continually strives to better serve the medical needs of MIT students. Access to health care at times convenient for students has received considerable attention. Plans are being formulated to institute a walk-in clinic for students four days a week in the afternoon and early evening.

In collaboration with two undergraduate students, the Vivo Project has been initiated. This web-based information system will make a wealth of resources available to the students. Confidentiality policy issues have been reviewed with students, parents and members of the Dean's office. Work has almost been completed on a clear and comprehensive document that outlines our policy and will be made available to students and parents.

For those students purchasing the MIT supplemental medical care policy, the mental health benefit has been increased. Students may have unlimited outside mental health visits on referral to participating mental health professionals.

Mental Health Service, Peter A. Reich, M. D., Chief
During the year a walk-in service was established and utilization has increased markedly with community awareness of the program. Although this service is geared toward the needs of students, it is available to all eligible members of the community. Monthly utilization rose to a high of 95 patient visits in May. Forty-five percent of the patients were new to the Mental Health Service and 75 percent of the walk-in patients were students. An overall rise in new patients among the students population suggests that outreach and publicity efforts have been successful.

An internal review process aimed at improving operations and planning for future needs has been undertaken. Preliminary recommendations include increasing the size of the staff, grouping providers into three teams, creating the position of Associate Chief, improving the flow of information regarding the care of high-risk patients, and evolving standards for patient evaluation and record keeping.

During the year a Mental Health Task Force was created and charged with the goal of assessing the status of Mental Health care on campus and making suggestions for improvement. It was co-chaired by Kristine Girard, M.D. and David Mellis, '02, and included undergraduates, graduate students, and representatives from the Office of Student Life, CSS, and housing, faculty, Health Education, Mental Health, and Medical Department administration. The Task Force reviewed mental health programs in other schools, studied the operations of the Mental Health Service, and surveyed student opinion and experience with mental health care at MIT. The Task Force report (in draft form) recommends increasing outreach and education, increasing the clinical staff, improving communication with housemasters, deans and faculty, and considering a satellite mental health office at the west end of campus.

Three long-term staff members left during the year: Ron Fleming became director of a substance abuse program in Hartford, Howard Ramseur moved to San Francisco, and David Henderson left to devote more time to research and academic activities. Three new providers joined the staff: Jack Lloyd, M.D., Suze Prudent, Ph.D., and Araceli Isenia, LICSW. Trainees with the Service included Fabiana Wallis, Ph.D., Lorraine Gray, Ph.D., Timothy Kelly, M.D., Kathleen Petruska, M.D., and two senior students from Simmons School of Social Work, Laura Moellentine and Peter Salgo. Jennifer Recklet was promoted to Program Coordinator, a staff position with responsibility for Spouses and Partners at MIT

Paulette Wood won the Medical Department's Lifetime Achievement Award. Bina Patel replaced David Henderson as one of the two Mental Health *ex officio* members of the CAP. Dr. Reich announced he would be stepping down as Chief of Mental Health as of June 30, 2002. He plans to remain on the clinical staff.

Surgical Services, Lawrence T. Geoghegan., M.D., Chief
General Surgery
The general surgical service continued to be very active at the Massachusetts General hospital and at the Mount Auburn Hospital. The service provides five-day a week on site clinical coverage and 24-hour daily and weekend coverage. State of the art care for a number of conditions is provided by members of the general surgical staff. An important, on going performance improved initiative focused on the care of abdominal pain has led to significant reduction in the number of complications associated with appendicitis. The service is in the final stage of producing a guide pamphlet for evaluation of abdominal pain. In the past year, approximately 170 major operative cases were performed at our affiliated hospitals.

Orthopedics
The service also provides five-day week clinic coverage and, during the school year, offers sports medicine clinics at the athletic facility. In addition, there is 24 hours/seven days a week emergency coverage. A full range of services is provided using a combination of facilities on campus and at the Mount Auburn and Massachusetts General Hospitals.

Otolaryngology
A full range of otolaryngologic and head and neck surgical services are provided for adults and children. The division offers, in addition to traditional head and neck surgery, state of the art endoscopic sinus surgery, including image guided technology, and radio-frequency ablation for treatment of obstructive sleep apnea.

Urology
Two urologists provide onsite care and emergency coverage for a wide variety of urologic problems. Our patients have access to state of the art treatment for prostate cancer, stone disease and other urology problems.

Nursing Service, Laureen K. Gray, R.N., C. S., Chief
Members of the Nursing Service continue to provide clinical care throughout the MIT Medical Department, including Urgent Care, Internal Medicine, MIT Medical-Lexington, Orthopedics, Pediatrics, Mental Health, OB/GYN, Occupational Health, and in our 18-bed Inpatient Unit. The service consists of nurse practitioners, registered nurses, a physician assistant, and clinical assistants.

The nursing service participates in a number of outreach efforts, including freshman orientation, new student registration, flu vaccine clinics in the fall, and IAP activities. Nursing has worked collaboratively with our Health Education Service, providing health information to our community of students in a variety of programs on campus, frequently in living units.

Several MIT nurse practitioners and registered nurses provide supervision for graduate and undergraduate nursing students from the major colleges and universities in the Boston area. The Nursing Continuing Education Committee organized the Annual Nursing Conference Day, which focused on Pain Assessment and Management.

Several performance improvement initiatives have been designed and implemented by members of the nursing service in collaboration with other clinical and support staff. Our initiatives for this year have focused on patient education and pain assessment and management.

Administration, Operations, Health Plans, and Financial Management
Annette Jacobs, Executive Director; Michael Glover, Communications Manager; Shelagh Joyce, Director, Information Systems; Ellen Offner, Director, Health Plans and Finance; Anthony Rogers, Director, Operations
The senior clinical and administrative leadership of the department has been meeting in a series of retreats to increase collaboration, and to establish goals and a plan for improving coordination and communication within the department to help support the new Medical Director. There have also been changes in leadership in the administrative areas of the department. Both Shelagh Joyce and Ellen Offner joined the administrative team as Director of Information Systems and Director of Health Plans and Finances, respectively, in October 2000. They co-led a cross-functional team for an extremely successful implementation of Phase II of our computer system. This phase affects all areas of the department and includes greater and more sophisticated automated business functions, including complex interfaces with MIT systems. We also began automation of clinical functions. There is increasing collaboration with the clinical leadership of the department to move toward an electronic medical record. We are also beginning to plan for the implementation of the Health Insurance Portability and Accountability Act (HIPAA).

Within clinical operations, we have completed a process in development for several years—each clinical service now has a clinical coordinator who works closely with the chief of the service to manage the clinical operations. The clinical coordinators, some of whom are clinically trained and others of whom are administratively trained, are led by Laureen Gray, Director of Nursing, and Anthony Rogers, Director of Operations.

Our ComMITment to Care program continues. We now have a full-time manager for this program and are beginning to use the first year of data from our patient satisfaction surveys to set goals for the coming year.

We continue to balance fiscal responsibility with meeting the health needs of the community. In response to the needs of both students and employees for enhanced coverage for outpatient psychotherapy, both the MIT Health Plans and the Extended Student Hospitalization Plan have increased outpatient mental health benefits.

Members of the administrative staff have been key participants in the provision and assessment of financial, statistical, and trend information for the Department's strategic planning process. With the finalizing of the Plan this Fall, all administrative staff will be involved in implementation of the identified initiatives. This effort is already underway through participation in working groups around five major areas identified as priorities for the Plan.

The Marketing and Communications staff has been increased which has allowed a redesign of the department's internal electronic newsletter. In addition, both the print and web version of *health@mit*, one of our major sources for communication of health related information within the MIT community have been reformatted. As part of a student outreach effort, our staff is working collaboratively with students on VIVO@MIT. The goals are to:
- Draw students to MIT Medical and other health resources available on campus;
- Provide health information to students;
- Provide health content that is MIT specific;

- Increase student trust of MIT Medical; and
- Use VIVO as a model for revamping MIT Medical's web site for other audiences.

Table 3. Appointments and Terminations: June 1, 2000 through May 31, 2001

Appointments		
Arthur, Robert	09/01/2000	Nurse, Inpatient
Busby, Judith	10/09/2000	Clinical Service Coordinator
Cox, Mary	11/27/2000	Director of Health Education
Collura, Grace	07/05/2000	Dentist
Duplaga, Melanie	02/05/2001	Dentist
Isenia, Araceli	01/17/2001	Social Worker
Joyce, Shelagh	10/16/2000	Director, Information Systems
Morehead, Sheila	09/25/2000	Pediatric Nurse Practitioner
Offner, Ellen	10/09/2000	Director, Finance and Health Plans
Prudent, Suze	11/15/2000	Psychologist
Rhinehart, Mary Ellen	01/09/2001	Associate Physician
Starr, Barbara	05/01/2001	Nurse Coordinator, Dermatology
Thompson, Diane	03/12/2001	Assistant Laboratory Manager
Wahl, Katherine	10/02/2000	Communications Coordinator
Westford, Wendy	08/01/2000	Dental Hygienist
Woodard, Eleanor	11/27/2000	Nurse, Inpatient
Terminations		
Brown, Linda	09/05/2000	Internist
Byrne, Leslie	04/30/2001	Administrative Assistant
Chivian, Eric	06/30/2000	Psychiatrist
Cox, Mary	01/12/2001	Director of Health Education
Egler, Leslie	08/31/2000	Psychologist
Hinderlie, Holly	09/30/2000	Psychologist
Fadel, Julie	10/20/2000	Assistant Chief Medical Technologist
Fleming, Ronald	04/20/2001	Social Worker
Foster, Stanley	05/31/2001	Radiologist
Foureau, Nadia	07/15/2000	Nurse, Inpatient
Hashemi, Shabnam	08/15/2000	Infection Control Coordinator
Henderson, David	12/30/2000	Psychiatrist
Lyden, Michelle	07/21/2000	Pediatric Nurse Practitioner
O'Connor, Sharon	12/01/2000	Nurse, Inpatient
Perkins, Mark	09/30/2000	Senior Project Manger
Ramseur, Howard	09/30/2000	Clinical Psychologist
Sornkul, Ekkasak	05/01/2000	Prosthodontist
Thompson, Diane	04/13/2001	Assistant Laboratory Manager
Weinberg, Arnold	08/31/2000	Medical Director (Retirement)
Changes		
Baral, Gina	01/01/2001	Health Educator for Students (Promotion)
DeGraan, Judith	03/01/2001	Enrollment Administrator (Promotion)
Diamond, David	01/01/2001	Chief, Internal Medicine (Promotion)
Hertema, Mary	03/01/2001	ComMITment to Care Coordinator (Promotion)
Kettyle, William	08/01/2001	Medical Director (Promotion)

William M. Kettyle, M.D.

FACULTY AND ACADEMIC STAFF COUNT AS OF OCTOBER 2000

DEPARTMENT	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	*Subtotal - Tenure Track Faculty*	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff*	GRAND TOTAL	Teaching Assistant	Research Assistant
PRESIDENT'S OFFICE																															
CHAIRMAN OF THE CORPORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
SECRETARY OF THE CORPORATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**0**	**0**
PROVOST'S OFFICE																														
CENTER FOR ADVANCED EDUCATIONA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	6	0	0
CHANCELLOR'S OFFICE	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	0	0
DIBNER INSTITUTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1	0	0	0	0	0	11	0	0	0	26	0	0
INSTITUTE PROFESSORS	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	12	0	0
OFFICE OF THE PROVOST	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	0	4	0	1	19	0	0
SUB-TOTAL	**0**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**14**	**1**	**0**	**0**	**0**	**0**	**1**	**24**	**1**	**6**	**0**	**11**	**66**	**0**	**0**
SCH OF ARCH & PLN																														
ARCHITECTURE, DEPARTMENT OF	2	10	7	4	4	8	3	0	0	0	0	2	12	0	1	0	1	3	3	4	5	2	0	5	0	0	0	9	77	99	17
CENTER FOR ADVANCED VISUAL STU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	8	0	0
CENTER FOR REAL ESTATE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
MEDIA ARTS AND SCIENCES SECTIO	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
MEDIA LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	4	0	7	0	1	23	0	0
PROGRAM IN MEDIA ARTS AND SCIE	2	3	4	5	6	11	1	0	2	0	2	1	1	0	0	4	0	0	2	2	4	1	0	1	0	3	0	0	44	0	138
SCHOOL OF ARCHITECTURE AND PLA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	5	0	0	0	0	8	0	0
URBAN STUDIES & PLANNING, DEPA	4	12	2	1	5	6	4	0	0	0	4	4	8	0	0	2	1	20	0	2	1	1	3	6	0	0	0	2	82	9	16
SUB-TOTAL	**9**	**25**	**13**	**10**	**15**	**25**	**8**	**0**	**2**	**0**	**6**	**7**	**21**	**0**	**1**	**6**	**3**	**27**	**22**	**8**	**10**	**4**	**3**	**22**	**0**	**10**	**0**	**12**	**244**	**108**	**171**
SCH OF ENGINEERING																														
AERONAUTICS AND ASTRONAUTICS,	2	15	3	6	4	10	2	0	0	2	6	12	13	0	2	7	1	0	13	1	3	1	0	0	2	0	0	3	98	8	172
ARCHAEOLOGY, DEPARTMENT OF	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
ARTIFICIAL INTELLIGENCE LABORA	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	0	0	11	0	0	1	0	0	0	6	0	0	26	0	0
BIOTECHNOLOGY PROCESS ENGINEER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	1	0	0	4	0	0
CENTER FOR INNOVATION IN PRODU	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	6	0	0
CENTER FOR TECHNOLOGY, POLICY,	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	3	0	0	0	0	6	0	1	0	0	13	0	0
CENTER FOR TRANSPORTATION STUD	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	5	0	0	8	0	0
CHEMICAL ENGINEERING, DEPARTME	4	18	4	3	3	6	0	0	0	0	1	4	2	1	0	36	10	0	19	0	2	0	1	3	0	6	0	4	121	19	163
CIVIL AND ENVIRONMENTAL ENGINE	5	18	4	5	6	11	0	1	0	1	3	2	7	0	0	10	10	0	9	0	0	0	0	9	2	4	0	2	98	34	134
DIVISION OF BIOENGINEERING & E	2	1	2	1	2	3	0	0	1	0	1	0	1	1	0	18	11	1	4	0	0	0	0	1	0	0	0	1	48	7	21
ELECTRICAL ENGINEERING & COMPU	12	62	12	11	14	25	3	0	1	1	10	9	7	2	4	2	0	0	4	2	1	1	0	0	0	3	0	2	163	112	514
ENGINEERING SYSTEMS DIVISION	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	6	0	0
INTEGRATED STUDIES PROGRAM	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
LAB FOR ELECTROMAGNETIC & ELEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	2	0	0	0	8	0	0
LAB FOR MANUFACTURING & PRODUC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0
LABORATORY FOR COMPUTER SCIENC	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4	4	0	11	0	0	0	0	2	0	15	0	0	38	0	0
LABORATORY FOR INFORMATION AND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	10	0	0	0	0	1	0	3	0	0	15	0	0
LEADERS FOR MANUFACTURING PROG	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
MATERIALS PROCESSING CENTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	5	2	0	1	0	0	0	0	0	0	5	0	0	21	0	0
MATERIALS SCIENCE AND ENGINEER	5	19	3	2	4	6	0	1	0	0	5	3	6	0	4	22	3	0	13	2	1	0	1	1	1	6	0	0	102	8	139
MECHANICAL ENGINEERING, DEPART	4	32	6	7	5	12	3	0	1	0	17	9	19	0	5	18	1	0	2	0	1	0	0	4	1	6	0	0	141	33	252
MICROSYSTEMS TECHNOLOGY LABORA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	0	0	0	0	0	0	9	0	0	16	0	0
NUCLEAR ENGINEERING, DEPARTMEN	1	11	3	1	1	2	1	0	1	0	3	1	1	0	0	2	0	0	14	0	0	0	0	1	2	3	0	1	47	13	84
OCEAN ENGINEERING, DEPARTMENT	2	9	0	3	0	3	0	0	0	0	2	4	6	0	0	4	2	0	7	3	0	0	0	1	2	0	0	5	50	4	38
SCHOOL OF ENGINEERING	0	2	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	71
SYSTEM DESIGN AND MANAGEMENT P	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
TECHNOLOGY AND POLICY PROGRAM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SUB-TOTAL	**37**	**189**	**37**	**39**	**39**	**78**	**10**	**2**	**8**	**5**	**50**	**52**	**66**	**4**	**23**	**142**	**44**	**1**	**133**	**9**	**9**	**3**	**2**	**32**	**14**	**74**	**0**	**19**	**1043**	**242**	**1588**
SCH OF HUM, ARTS & S																														
ANTHROPOLOGY PROGRAM	1	3	1	0	1	1	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	13	0	0
CENTER FOR INTERNATIONAL STUDI	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	8	0	0	0	0	17	0	0	0	1	39	0	0
ECONOMICS, DEPARTMENT OF	1	19	1	2	8	10	0	0	0	0	1	1	0	0	0	0	0	0	0	6	3	0	1	11	0	0	0	0	54	31	11
FOREIGN LANGUAGES & LITERATURE	1	4	1	1	1	2	0	0	0	0	0	4	25	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	39	0	0
HISTORY SECTION	2	4	3	2	2	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	15	0	0
LINGUISTICS AND PHILOSOPHY, DE	1	8	3	6	2	8	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	1	0	30	0	0	0	0	55	10	16
LITERATURE SECTION	1	7	3	1	2	3	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	23	1	11
MUSIC AND THEATER ARTS SECTION	2	5	1	1	2	3	0	0	0	0	0	6	10	0	3	0	0	0	0	0	0	0	0	1	0	0	0	6	37	0	0
POLITICAL SCIENCE, DEPARTMENT	1	9	3	4	6	10	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	4	0	0	0	0	30	20	29
PROGRAM IN SCIENCE, TECHNOLOGY	1	6	2	1	3	4	0	0	0	0	0	1	1	0	0	0	0	10	0	2	0	0	0	8	0	0	0	0	35	5	2
PROGRAM IN WRITING AND HUMANIS	1	6	0	1	1	2	1	0	0	0	0	1	17	0	13	0	0	0	2	0	0	0	0	0	0	0	0	0	43	0	0
SCHOOL OF HUMANITIES, ARTS AND	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0
SUB-TOTAL	**12**	**71**	**18**	**19**	**28**	**47**	**1**	**0**	**0**	**0**	**2**	**13**	**66**	**1**	**16**	**1**	**1**	**22**	**12**	**9**	**5**	**1**	**1**	**79**	**0**	**0**	**0**	**7**	**385**	**67**	**69**
SCH OF MANAGEMENT																														
ORGANIZATIONAL LEARNING CENTER	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SLOAN SCHOOL OF MANAGEMENT	3	52	4	6	31	37	1	0	4	0	4	19	2	0	0	3	1	0	1	10	4	3	2	26	0	2	0	2	180	129	60
SUB-TOTAL	**3**	**52**	**4**	**6**	**31**	**37**	**1**	**0**	**4**	**0**	**4**	**20**	**2**	**0**	**0**	**3**	**1**	**0**	**1**	**10**	**4**	**3**	**2**	**26**	**0**	**2**	**0**	**2**	**181**	**129**	**60**
SCH OF SCIENCE																														
BIOLOGY, DEPARTMENT OF	4	29	4	5	9	14	0	0	0	0	9	1	0	0	5	48	50	0	49	1	0	0	0	11	0	12	0	5	242	0	106
BRAIN AND COGNITIVE SCIENCES,	2	12	3	2	6	8	0	0	1	0	3	0	3	0	2	15	19	0	22	1	1	0	3	1	0	3	0	0	99	16	8
CENTER FOR CANCER RESEARCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	20	0	33	0	0	0	0	2	0	6	0	1	87	0	0
CENTER FOR LEARNING AND MEMORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	8	0	2	0	0	0	0	1	0	0	0	3	25	0	0

DEPARTMENT	Professors in Administration	Professor	Associate Professor with Tenure	Associate Professor without Tenure	Assistant Professor	*Subtotal - Tenure Track Faculty*	Adjunct Professor	Senior Research Associate	Senior Research Scientist	Senior Research Engineer	Professor (non-tenure)	Senior Lecturer	Lecturer	Instructor	Technical Instructor	Postdoctoral Associate	Postdoctoral Fellow	Research Fellow	Research Affiliate	Visiting Professor	Visiting Associate Professor	Visiting Assistant Professor	Visiting Lecturer	Visiting Scholar	Visiting Engineer	Visiting Scientist	Coach/Trainer	Other Academic Staff*	GRAND TOTAL	Teaching Assistant	Research Assistant
CENTER FOR SPACE RESEARCH	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	11	6	0	4	0	0	0	0	1	0	2	0	0	26	0	0
CHEMISTRY, DEPARTMENT OF	3	18	0	2	6	8	0	0	0	0	4	0	0	0	1	41	48	0	4	0	0	0	0	7	0	8	0	0	142	56	156
EARTH, ATMOSPHERIC, & PLANETAR	1	30	1	1	1	2	1	0	1	0	4	1	1	1	0	29	7	1	12	5	1	1	0	0	0	17	0	1	117	15	66
EXPERIMENTAL STUDY GROUP	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	7	0	0
LABORATORY FOR NUCLEAR SCIENCE	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	12	0	0	15	0	0	0	0	0	0	28	0	8	66	0	0
MATHEMATICS, DEPARTMENT OF	1	31	3	1	16	17	0	0	0	0	0	1	1	21	0	1	5	0	11	3	2	2	0	16	0	1	0	1	117	58	12
PHYSICS, DEPARTMENT OF	8	43	2	4	13	17	0	0	5	0	17	2	0	0	4	6	12	0	1	7	0	0	0	2	0	12	0	10	148	41	160
SCHOOL OF SCIENCE	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0
SPECTROSCOPY LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	32	0	0	36	0	0
SUB-TOTAL	**19**	**164**	**13**	**15**	**51**	**66**	**1**	**0**	**12**	**0**	**37**	**6**	**9**	**22**	**12**	**202**	**175**	**1**	**153**	**17**	**4**	**3**	**3**	**43**	**0**	**121**	**0**	**31**	**1114**	**186**	**508**
TREASURER'S OFFICE																															
TREASURER'S OFFICE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**
VP - HUMAN RESOURCES																															
MEDICAL DEPARTMENT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	118	118	0	0
VICE PRESIDENT FOR HUMAN RESOU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**119**	**119**	**0**	**0**
VP & DEAN - RSCH																															
CENTER FOR BIOMEDICAL ENGINEER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0
CENTER FOR ENVIRONMENTAL HEALT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0	0	6	0	0
CENTER FOR MATERIALS SCIENCE A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	1	0	0	4	0	0
CLINICAL RESEARCH CENTER	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	11	0	18	0	0	0	0	0	0	34	0	4	68	0	0
DIVISION OF COMPARATIVE MEDICI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	0	4	0	0	0	0	0	0	9	0	5	26	0	0
ENERGY LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	1	0	8	3	4	0	0	21	0	0
FRANCIS BITTER MAGNET LABORATO	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	1	0	16	0	0	25	0	0
HAYSTACK OBSERVATORY	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	1	0	0	0	0	6	0	0
HRVD-MIT DIVISION OF HEALTH SC	0	5	0	0	0	0	0	0	2	0	1	0	4	0	0	9	11	1	31	4	0	0	0	14	0	12	0	93	187	5	90
NUCLEAR REACTOR LABORATORY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	7	0	1	14	0	0
PLASMA SCIENCE AND FUSION CENT	0	0	0	0	0	0	7	1	0	1	0	1	0	0	0	2	0	0	17	0	0	0	0	2	1	34	0	0	65	0	0
RESEARCH LABORATORY OF ELECTRO	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	18	5	0	62	0	0	0	0	0	0	28	0	0	114	0	0
SEA GRANT COLLEGE PROGRAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	2	0	0
TECHNOLOGY AND DEVELOPMENT PRO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	3	0	0
WHITAKER COLLEGE OF HEALTH SCI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SUB-TOTAL	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**12**	**1**	**2**	**1**	**4**	**0**	**0**	**45**	**36**	**1**	**146**	**4**	**0**	**1**	**0**	**27**	**5**	**151**	**0**	**103**	**544**	**5**	**90**
DEAN-UNDERGRAD EDUC																															
AIR FORCE AEROSPACE STUDIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	6	0	0
MILITARY SCIENCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0	1	2	9	0	0
NAVAL SCIENCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	9	0	0
OFFICE OF ACADEMIC SERVICES	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**18**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**25**	**0**	**0**
VP - RESOURCE DEV																															
OFFICE OF THE VICE PRESIDENT O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**
DEAN-STUDENT LIFE																															
ATHLETIC DEPARTMENT	0	0	5	4	6	10	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	22	2	43	0	0
CAMPUS ACTIVITIES COMPLEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
DEAN FOR STUDENT LIFE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
SUB-TOTAL	**0**	**0**	**5**	**4**	**6**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**22**	**3**	**48**	**0**	**0**
EXEC VICE PRESIDENT																															
ENVIRONMENTAL MEDICAL SERVICE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	27	0	0
SUB-TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**27**	**27**	**0**	**0**
ADMINISTRATION	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9**	**9**	**0**	**0**
FINAL TOTALS	**80**	**513**	**90**	**93**	**170**	**263**	**21**	**2**	**38**	**6**	**102**	**99**	**168**	**32**	**74**	**399**	**274**	**53**	**467**	**60**	**32**	**15**	**12**	**253**	**20**	**364**	**23**	**349**	**3809**	**737**	**2486**

VICE PRESIDENT FOR INFORMATION SYSTEMS

Information Systems (IS) is responsible for ensuring that MIT's information technology (I/T) resources are aligned with the Institute's strategic priorities, and that I/T services are consistent, reliable, easy to use, and operated productively and cost-efficiently.

IS fulfills an essential and vital role in furthering MIT's core missions of education, research, and service by working in partnership with members of the MIT community to apply and help them apply I/T to achieve their mission and reach their goals. This year IS received some 100,000 requests for help and service changes, ranging from upgrading telephone and network service to installing a new office computing environment, to assisting faculty in using computers in their teaching, to supporting major MIT strategic initiatives such as OpenCourseWare (OCW). Faculty, students, and staff in departments, laboratories, and centers interact with IS in obvious ways daily: they call the Computing Help Desk with Macintosh, PC, and UNIX hardware or software questions; or they call the Business Liaison Team (BLT) with questions about business applications. But departments also rely on IS in more intrinsic ways. When anyone at MIT turns on a computer—in an office, in an Athena cluster, in a lab—and sees the network; when someone picks up a telephone receiver and hears dial tone; when someone backs up the documents and data on their computer to the Data Centers in Buildings W91 and W92 or otherwise uses the servers in the data centers, they are interacting with IS.

IS's goal is to provide a world-class information technology environment for MIT's world-class faculty, students and staff. To this end, IS provides "commons" services such as computing help, voice and data network connectivity, data storage, software acquisition and support, and the Athena computing environment. IS's services range from strategic partnerships at the MIT-wide level to operational services and support at the departmental and individual level.

Many of IS's wide range of services are provided at no cost to departments, laboratories, and centers. Others (such as telephone and network services) are provided on a cost-recovery basis or through competitive prices to cover the costs of these resources. Providing the comprehensive I/T services needed at MIT requires considerable resources: physical resources (such as space for staff and equipment including phone closets in departments, laboratories, and centers); human resources (such as staff time for work assignments and for training and retraining); and monetary resources (such as funding for equipment, and software acquisition and renewal).

IS strives to meet client needs by anticipating the future and adjusting the IS organizational framework, as well as its products and services, as necessary to meet the Institute's changing requirements and the ever-increasing use of existing IS products and services. In May 2001, IS realigned its organizational framework in response to client feedback. The intent of this realignment was threefold: to ensure the visible, measurable progress on priority goals; to ensure orderly, timely transfers of work (i.e., handoffs) between IS groups; and to ensure continuous improvements of IS activities and processes. IS's new organizational framework is depicted in Table 1.

In this realigned model, IS has extended its concept of an "I/T Practice" to include I/T architecture and infrastructure planning. A new practice—the Architecture and Infrastructure Practice (A&IP), led by Susan Minai-Azary—joins the Academic and Office Computing Practices to advocate both on behalf of clients to IS, and on behalf of IS to clients to promote and enable innovative technology-based work at MIT. The Discovery Council was introduced to more effectively translate client requirements into the work of IS's I/T Processes—Discovery, Delivery, Service, Support, and Telecommunications and Network Services. (This last process, the I/T Telecommunications and Network Services Process, is another key realignment in the IS organization. This change was made in direct response to customer feedback regarding IS's telecommunications and network service offerings.) The I/T Competency Group (CG) concentrates on the skills dimension of Information Systems, working to provide a staff well qualified to meet both current and future work requirements. CG, the Administrative Business Services Team, and the Office of the Vice President for Information Systems all support the core business of IS.

During FY2001, IS staff achieved an impressive range of accomplishments. We have organized these accomplishments according to the five operational themes—client orientation, collaboration, sustainability, accountability, and professionalism—suggested in the Executive Vice President's Report to the President for 1999–2000.

Table 1. Information Systems Organization Model

	Academic Computing Practice *Vijay Kumar*	Office Computing Practice *Theresa Regan*	Architecture and Infrastructure Practice *Susan Minar Attaya*
Discovery Process *(self-managed team of project managers in lieu of a Discovery Director)*			
Delivery Process *Bob Ferrara*			
Service Process *Roger Roach*			
Support Process *Greg Anderson*			
Telecommunications and Network Service Process *Allison Dolan*			
Competency Group and Administrative Business Services *Allison Dolan*			

The shaded area denotes the "Discovery Council."

CLIENT ORIENTATION

In his report, the Executive Vice President defined "client orientation" as listening to and understanding the service needs of colleagues in departments, laboratories, and centers, and then working with those colleagues to resolve problems and streamline processes in support of the Institute's primary academic and research mission. Much of IS's work is aligned with this theme as we strive to create clear lines-of-sight between IS service providers and our clients. Key accomplishments within this focus include the following.

In fall 2000, IS conducted a formal, on-line customer satisfaction survey. This survey was a key component of concentrated IS efforts to better assess the needs of our customers in order to sharpen our focus for the future. Almost 600 people—of whom 14 percent were faculty, 42 percent were students, and 44 percent were administrative/support staff—responded to the survey; a detailed report is available at http://web.mit.edu/measures/survey/report/. Based on this client feedback, IS is currently pursuing a series of initiatives to improve its service offerings to the MIT community. These include: delivering 100 Mb/s network service to the desktop; improving our communication with our customers (e.g., improving IS web page content and design, and workshops to build staff competency in communicating with clients); decreasing process time for network and telephone jack installations, and increasing communication about the status of requested jack installations; increasing communication and reducing cycle-time between the public release and MIT availability of supported software; increasing Help Desk/Call Center coverage by staff, reducing telephone time on-hold waiting for a consultant, and increasing the percentage of calls answered; and in addition to decreasing the price for "Tether" remote access connectivity on July 1, 2001, we are also working to identify other off-campus connectivity options for the MIT community.

IS continued to improve its front-line support of the MIT community. During fiscal year 2001, the Computing Help Desk received over 25,000 calls and created 13,400 cases. The average time to answer calls in the fourth quarter was 59 seconds, continuing improvements begun early in the year. At the end of the year, the Help Desk was answering 85 percent of its calls live, a 10 percent increase since the beginning of the year. The Business Liaison Team answered over 5,500 calls from users of enterprise-wide administrative applications. Assistance was provided for 48 software packages. The average time to answer a call was 20 seconds and over 90 percent of the calls were resolved in less than one day. Athena Consulting, User Accounts, and Residential Computing handled over 22,800 cases with over 90 percent accuracy for quality and timeliness. Academic Computing Support provided on-going services to faculty and worked to provide new functionality to Athena users such as support for long-running, compute-

intensive jobs and an improved user interface. Web Communication Services answered approximately 2,400 requests for web help and provided about 280 spotlight headlines on the MIT home page. IS Training provided over 400 training sessions involving almost 6,900 MIT clients and received a median satisfaction rating over 4.5 on a five-point scale. Departmental Computing Support had long-term agreements with 16 units on campus representing over 1400 clients during the year and logged over 1100 calls and tasks in support of the units' local technology needs. Adaptive Technology for Information and Computing (ATIC) provided assistance to 235 faculty, students, and staff in need of adaptive technologies, including providing accessibility audits and assisting those with learning disabilities. IS also formally launched the Usability Group, with participating members from IS, the MIT Libraries, FSS, and other departments. The group logged almost 20 activities with a variety of academic and administrative units. Their focus is on end-user design to enhance usability and to integrate human factors principles into enterprise-wide technologies.

IS also continued to sustain many critical, but less visible, services. The W91 Data Center continued to support Tivoli Storage Manager (TSM, formerly ADSM) for desktop backup, currently storing over 20 terabytes of data or almost double that from a year ago. During the past year, teams in the Data Center performed software upgrades for enhanced functionality and reliability, and also selected and began installing an Automated Tape Library to provide 24/7 access and to reduce operator time required for mounting of tapes. The VM Services Team maintained the LISTSERV software and over 1000 mailing lists; mailing list subscribers grew by almost 60 percent to 300,000.

To address specific client feedback, the Transmissions Team in the Service Process and portions of the Computing Help Desk and Departmental Computing Services Teams from the Support Process were reorganized and combined in fiscal year 2001 to create the Voice/Data Installation Services Team (VDIST). This team provides a more comprehensive solution for telecommunications in new construction, renovations, moves, and day-to-day situations. VDIST worked to streamline these processes, including becoming more involved with the billing process and leveraging available assistance from the E19 Site Team. New agreements were established with cabling installation contractors to facilitate the processes for installations of small numbers of jacks and to improve service times for the customers. VDIST was able to reduce turnaround times for network drop activation from an average of eleven days to four days, including installation of any required new jacks.

The Academic Computing Practice (ACP) continued to meet with departments, schools, and centers each semester to communicate about work happening in IS and to learn about the critical technology issues facing departmental faculty. From these "rounds," responses tailored to address faculty concerns were developed. Over the past year, specific targeted solutions included: assigning a Faculty Liaison to provide support to faculty in the School of Humanities, Arts, and Social Sciences in their offices; providing increased faculty consultation and custom tutorials and workshops; developing a technical solution to run "long jobs" (compute-intensive applications) in the Athena environment; and chartering a Wireless Laptop Pilot Project to meet the hardware and software support needs of four MIT Council on Educational Technology (MITCET) projects (TEAL; Teaching Computation in a Studio Setting in Course 1.00; Wireless Portable Computing in the Design Studio; and Portable, Wireless Computing for 2.001/2.005 Students). ACP also continued its annual Athena Renewal program. A total of 231 Athena workstations were deployed in academic year 2001–2002. These included 105 computers deployed in academic departments. In addition, one new residential computing Athena cluster (six machines) was created, and 16 QuickStations were upgraded. In April 2001, the first "Pismere" pilot was rolled-out to the Department of Urban Studies and Planning. The purpose of this project is to create a scaleable, centrally manageable environment of public Microsoft Windows 2000 workstations. Pismere is an extension to the existing MIT computing infrastructure, and includes a number of features and tools borrowed from Athena. Creating this environment involved extensive modifications and add-ons to Microsoft code and/or procedures in the areas of security and file and system management.

The Office Computing Practice (OCP) also focused on client communication and advocacy. OCP continued to direct and support the work of the Business Liaison Team (BLT), which provides front-line support (including the role of central authorization for SAP and other systems) to users of the Institute's administrative systems. In fiscal year 2001, OCP and ACP jointly chartered and funded the Computing Practices Resource Team (CPR). For OCP, this team provides both hardware and software expertise and deployment to departments across the Institute. This team is often able to quickly resolve high profile problems in a very wide set of circumstances. This year, CPR initiated a "Preventative Maintenance" program geared to departments with little or no technical resources. On a scheduled basis, a member of the team visits the department to assess hardware and software, and then completes all relevant

upgrades. This was also the first year of the Software Release Team (SWRT). During its first year, this team established regular, clear communications with the MIT community and reviewed all currently supported desktop products in order to address any gaps in product web pages and installers. (On a related note: After prolonged negotiations with Microsoft and their distributors, MIT signed Microsoft's Select Agreement and implemented it via our on-line purchasing partner. This agreement provides consistently discounted pricing for all major Microsoft applications.) OCP also focused its attention on MIT Personal Certificates (X.509), which allow for secure, authenticated access in web-based applications. To ensure that MIT web sites that desire secure access implement certificates as the security mechanism, OCP initiated a communication campaign to improve the MIT community's understanding of the importance of certificates and their use.

As a result of new federal laws, web page accessibility became a critical issue for MIT. This year, under the auspices of the new Architecture and Infrastructure Practice (A&IP), IS developed accessibility guidelines with practical examples for both purchasing and building software, taught an IAP class on this topic, and, via the Institute's I/T Architecture Group, sponsored an educational program with a speaker from Sun Microsystems about "Accessibility Support on the Java Platform."

Several projects also reflect IS's "client orientation." Three Discovery projects—Student Advising, a key initiative to redesign the student advising process for the Dean for Undergraduate Education (with links to the Council on Educational Technology); Spatial Data Services, which creates a new service for enterprise-wide use of spatial data; and Web Mail, an initiative to design/select a web-based email client to improve email access for the MIT community when traveling—and several Delivery projects rely on continued and ongoing interaction with our clients to meet goals and deliverables. The Delivery projects include: the HR-Payroll Delivery Project, which was formally begun in October 2000; and the Wireless Project, a project funded by the Provost that resulted in the installation of some 210 wireless network access points around MIT, ensuring that MIT's classrooms, libraries, and many of the campus' public areas are now served by a wireless computer network.

COLLABORATION

The second theme in Mr. Curry's call to enhance the utility, quality, and efficiency of administrative services is "collaboration"—"teamwork, boundary-blind business processes, and open sharing of common information." It is only through active collaboration that IS is able to get its work done. Examples from the year include the following.

IS collaboratively supports and contributes to major MIT initiatives, such as: iCampus, Stellar, Open Knowledge Initiative (OKI), Information Technology Architecture Group (ITAG), and the Data Warehouse. IS's Web Communication Services Team provided consulting and web development services to a number of units, including highly visible efforts such as OpenCourseWare and the Environmental Health and Safety activities.

The R3-Admin Team partnered with Financial Systems Services (FSS) to effect the upgrade of MIT's SAP systems to release 4.6C, and then partnered with both IS and SAP development staff to prototype a utility for importing MIT Certificate Information into SAP in order to support web-based SAP user access. R3-Admin also partnered with FSS and process owners to execute data archiving and the removal of unneeded Work Item, Payment Media, and Profit Center Accounting data from MIT's SAP systems.

A new Housing Lottery application was developed in partnership with the Office of the Dean for Student Life and put into production for summer/fall 2001. The new system permits a summer lottery for dormitory assignments in time for Orientation, and a fall lottery for permanent dormitory assignments. This new, more robust system requires high and extended availability to: authenticate pre-first-year and first-year students; collect individual and group housing preferences; and email and display on the web the dorm assignment.

An MIT Cable TV project was initiated to provide a new digital cable TV service to the MIT campus beginning on September 1, 2001. The vendor, Falls Earth Station, offers an innovative solution and directly addresses the concerns revealed by a cable services survey of students as well as issues expressed by the MIT Housing Office. The project will include a self-provisioning (self-service) feature that is an industry first. The number of channels provided will also increase dramatically and subscribers will be able to utilize additional customized services.

IS worked with Procurement, the Controllers Accounting Office (CAO), and FSS to solidify the Roles Database as the Institute's official authorization system. Roles now includes departmental authorizations to create requisitions,

and approve invoices and travel documents. A major milestone in the use of Roles was achieved when the Cost Object Supervisor Authorization project, which made explicit the authority to sign paper requisitions, and approve invoices or travel documents, was completed.

The IS R3-Admin Team partnered with FSS, CAO, and other IS personnel to assess the MIT SAP infrastructure options for accommodating Lincoln Laboratory financial operations.

IS Windows experts working with FSS staff configured six servers with increased security to support SAP's Internet Transaction Server (ITS) implementation. The ITS allows many SAP transactions to be securely conducted via the web.

IS and FSS collaborated with the MIT Libraries in their conversion to a new business system. In July, the older GEAC Advance system was replaced with a more current ALEPH system from Ex-Libris. IS contributed in vendor selection, project management coaching, security, and operations supports, while FSS helped with data feeds, and financial and procurement processing.

IS also collaborated with the Libraries and several departments in establishing a Spatial Data Services/ Geographical Information System (GIS) capability at MIT. GIS has its origins in the Department of Urban Studies and Planning and is now used in many other disciplines including Civil and Environmental Engineering, and Earth, Atmosphere, and Planetary Sciences. The initial stages of developing and establishing this service involved procuring a site license giving MIT faculty, staff, and students access to a large suite of GIS software and hiring a Spatial Data Specialist, who has also assisted in teaching this subject matter. A delivery project launched this year will enable campus-wide access to GIS software and datasets.

IS collaborated with the Libraries on the Dspace project which is building a prototype system for preserving digital content.

The EDI Operations Team began technical discussions with MIT Benefits regarding the use of EDI for transmitting data to Blue Cross and other carriers. Also, the team completed testing of the ANSI 834 Benefits Transaction with PGP encryption to enhance security.

The EDI Operations Team is working with Office Depot to use XML, instead of EDI, in the electronic exchange of data between this vendor and MIT's SAP system. When successful, work will begin to transition other purchasing partners to this more effective technology.

MIT witnessed an e-commerce milestone in October 2000, when the MIT Museum went on-line with a web catalog and a "back end" credit card processing capability. Interim technology was used as work continued to build a scalable, flexible in-house production system. Pilot use of the production system is anticipated in the fall in CAO for general receivables and in the Alumni Association for gifts.

The MIT Procurement Office and the MIT Computer Connection collaborated in a process that proposed new vendors as purchasing partners for computer supplies. These vendors will make their debut on the MIT electronic catalog later this fall.

The IS Data Center staff partnered with SSIT to configure and install a new environment for the SCT/Banner application. In addition to new servers, work was performed to replace existing system functionality.

The IS-led Business Continuation Team completed a successful simulation exercise with an evacuation and subsequent tabletop planning session for the Central Utilities Plant. A report on the result of this coordinated exercise, which involved personnel from Campus Police, Medical Department, Safety Office, Facilities, and the Central Utility Plant, was sent to senior management.

The Network Operations Team in collaboration with a number of clients, developed tools for conducting on-line surveys. These tools were used for the first time in the Athletics evaluation and the Student Center survey. The team also provided support for the COFE national survey administered at Indiana University.

The IS Director of I/T Staff Development and Resource Management worked extensively with Human Resources in many areas including co-leading the Recruiting Working Group (which led to hiring a recruiting manager); participating in the Human Resources Diversity Working Group; participating in the MIT-wide I/T salary review; contributing to Human Resources improvement opportunities (as a client of HR); and participating on an HR/Payroll Design Review Team as co-leader of HR/Payroll New-Hire-to-Orientation Design Team. In addition, CG staff volunteered as facilitators for HR/Payroll Design Teams.

IS's Support Process began to work with the Administrative Advisory Council II in an effort to define computing support requirements among the departments, laboratories, and centers. Support also continued to lead the Institute-wide "IT Partners" program which held five conferences and seminars during fiscal year 2001.

IS also collaborates with peer groups, such as CSG, IVY+, ACUTA, and Cartel, among others. With the eleven other Boston Consortium schools, the IS Training Team began offering free web-based computer training to the MIT community. This training is available at all hours of the day and night.

IS also partners with external vendors, such as Microsoft, Apple, and Dell. In a major industry press release last year, MIT announced a collaboration with Apple to make the MIT-developed Kerberos authentication system an integral part of Apple's operating system of the future, MacOS X. The MIT team has met its obligation by releasing MIT Kerberos for Macintosh version 4.0a15 last June. This same team also managed a major new release, version 3.5, of MIT Kerberos for older versions (MacOS 8 and 9) of the Macintosh operating system.

SUSTAINABILITY

IS is committed to developing an information technology infrastructure that provides the foundational capabilities needed to support the teaching, learning, research, and business needs of the Institute. IS's goal is to ensure that the MIT infrastructure is reliable, sustainable, and secure, and that it does indeed "stay the course," which is how the Executive Vice President describes the operational theme of "sustainability." Much of IS's on-going work centers on keeping the Institute's I/T services running as well as renewing and improving those services. Key accomplishments include the following.

MIT's information technology infrastructure lends sustainability to the entire I/T educational and business application suite. In order to have sustainable I/T at MIT we must upgrade, rebuild, and extend our I/T infrastructure. This year IS moved toward object technology with staff to mentor others and to build with Java technology. We began building Java interfaces to infrastructure services, built an end-to-end Java secure environment to communicate with enterprise databases, and began upgrading some of our infrastructure services from unsupported platforms to Java.

IS's Macintosh Kerberos Team developed the Kerberos code to be incorporated in the new Macintosh operating systems working to the Apple development timeline. Our Unix Kerberos developers completed a new release of the code for MIT and other sites using our code base. This work continues to make Kerberos a robust, reliable, and sustainable component to ensure the security of MIT's I/T infrastructure.

IS continued its very successful virus protection program for desktops avoiding again this year any major business outage related to viruses. We also worked cooperatively with the Campus Police to deploy security devices for laptops.

The Network Security Team opened 1352 security cases in the fourth quarter of FY2001, up from 497 for the same period one year ago. The Network Security team also carried out a set of extensive proactive and reactive responses to increased intruder activities associated with the U.S./China Hainan Island aircraft dispute. This series of events was very widespread, and we were able to react before MIT systems could be significantly impacted. The team also assisted the FBI with three cases having MIT connections, and participated in their INFRAGARD initiative along with major businesses and government agencies in the Boston area.

IS also worked to follow vendor and market directions and to track technology that is important to MIT, both for now and the future. These activities include testing supportability issues with multiple versions of Windows IE and MIT certificates, testing vendor "seed releases" of products we support, tracking software available for Mac OS X, and tracking PDA uses and applications.

Version 3.5 of COEUS extended the functionality required for research proposal development and routing from departments, laboratories, and centers to OSP. Additionally, this version included an enhanced "Money and End Date" screen that captures distributions to/from parent and child WBS elements within a single transaction.

In October, IS extended its supported enterprise email offering with production support of the IMAP email service. This new service enables clients to more effectively access their email from multiple machines in multiple locations.

The Enterprise Backup Project Team installed and configured backup equipment in E40. When complete, this effort will enhance the integrity and availability of the SAP system.

Needs for additional disk storage hardware have been deferred as a result of an IS/FSS archiving project, which successfully reduced storage requirements of the SAP databases by 23 percent. Several follow-on efforts are planned which are expected to further reduce disk storage requirements without compromising the SAP system.

The Enterprise Printing project installed and made operational a new web-accessible central printing environment, based upon IBM's Infoprint Manager. This allows IS to upgrade and revise the IS central print service so that it can better meet MIT's large volume enterprise print requirements. It also allows a seamless transition from the current printing process that utilizes the data center's mainframe.

The Software Release Team delivered 17 new versions of software to the MIT community in FY2001 with ten additional products currently in the release pipeline. This effort insures that viable versions of supported software applications will be available for MIT clients.

Telecommunications upgrades to ensure sustainability included work to install a new Lucent 5ESS telephone system, which is scheduled to go into service at the end of calendar 2001. It also included the rewiring of Buildings 8 and 66 to support 100Mb/s MITnet desktop service. Upgrades to the MITnet backbone for these and other buildings are planned for next year. The MITnet commodity Internet service was upgraded from 100Mb/s (FDDI) to 155Mb/s (OC-3C) and our connection to Internet2's Abilene network was upgraded to 622Mb/s (OC-12C) to meet increased bandwidth needs of the community.

In the W91 Data Center, the Data Center Operations and VM Teams completed their first full year utilizing the new storage area network (SAN), an enterprise storage and backup system for SAP which improves application performance, reliability and availability; maintained the mainframe systems running the VM/ESA operating system to support administrative clients such as Payroll and Admissions, the desktop backup service using the Tivoli Storage Manager product, and a mailing list service using the LISTSERV software package; achieved high availability with a total of three unplanned outages all year; and supported overall growth with an almost 50 percent increase in processor utilization. These teams also updated the Data Center's disaster recovery system to use a commercial recovery site. Working with IS's clients, the VM Team also performed successful business continuity tests of both the Admissions and Payroll applications.

The Database Services Team provided installation, backup, tuning, and maintenance support for over 70 administrative databases, while ensuring that databases were available over 99.99 percent of scheduled uptime. The Database Team also created or upgraded over 40 databases, and responded to approximately 600 email support requests.

Teams under the purview of the Office Computing Practice worked closely with several large departments, laboratories, and centers to set and promote threshold hardware and software standards. OCP strives to ensure that all organizational units who rely on SAP have their hardware and software requirements met well in advance of any SAP system upgrade.

To ensure sustained staff excellence, CG continued to employ a dedicated recruiter, who brought a much needed focus to IS's staffing efforts, increasing the number of candidates per search (one technical search had close to 400 applicants), decreasing the time to hire, and improving hiring skills on part of hiring managers.

IS is a key contributor to the OKI project which focuses on designing and developing an open, sustainable, on-line platform to support teaching and collaboration. OKI is funded by a grant from the Andrew W. Mellon Foundation,

and will provide an open, extensible architecture as well as a set of web enabled learning components for a wide range of educational environments. Principle partners with MIT in the project are Dartmouth College, Harvard University, North Carolina State University, Stanford University, the University of Michigan, the University of Pennsylvania, and the University of Wisconsin-Madison.

ACCOUNTABILITY

The Executive Vice President discussed "accountability" as that which is "necessary to hold everything together, but accountability only exists when we measure deviation from standards, obligations, and commitments, and when it is both organizational and personal. A necessary condition for accountability is clarity of roles and responsibilities. A second necessary condition is that we in fact measure and provide the feedback that forces correction at worst, and promotes continuous improvement at best." IS work in this thematic area included the following:

IS leadership focused on improving IS's project tracking and quarterly reporting this past year. IS made public the components of its Operational Plan with the development of the "IS-Work" database which may be accessed online at http://iswork.mit.edu/iswork/. This effort has already attracted considerable attention outside MIT as a good model for making work visible. (A Stanford University study had identified this as best practice work.)

IS has followed up its fall 2000 Customer Satisfaction Survey with shorter "snapshot" surveys designed to keep IS accountable to customers on a continuing basis. Results from these surveys feed into new strategic performance measures throughout the IS organization and drive continuous improvement activities.

The Competency Group (CG) spearheaded efforts to turn updating job descriptions and performance appraisals into an ongoing activity. CG also modified IS's performance appraisal process to reflect the Institute's new administrative staff classification system, and defined generic job descriptions for I/T staff using the Institute's then-current tool (eValuation). Throughout the year, CG worked to increase consistency and accountability across IS around the use of competencies in selecting staff for specific work assignments. As part of this effort, CG worked with the Discovery and Delivery Processes to institute a new process for project performance appraisals.

IS also responded to Institute requests to be more accountable for the telephone and network rates by implementing a new internal cost accounting structure, which supports more frequent and accurate analysis of rate-based revenues and related expenses. IS also implemented new network and telephone usage rates approved by the Budget and Finance Steering Group. The reduced rates are projected to save Institute departments, labs, and centers over $800,000 per year.

IS's organizational realignment clarified roles and responsibilities across IS. For example, the realignment catalyzed the creation of the Enterprise Application Software Team (EAST), headed by an MIT veteran employee. The team's purpose is to take responsibility for the upgrades, periodic maintenance, and pro-active migration of IS-maintained enterprise applications, such as COEUS, ICE9, TNS Billing, the housing and athletics lotteries, SAPweb, and others, into the Service and Support processes. As a result of a very energetic February Academic Computing Practice offsite, discussions have now begun around creating a similar team to serve academic needs.

PROFESSIONALISM

Mr. Curry describes his fifth theme—"professionalism"—as "striving for leadership across all the professions which define us beyond our roles at MIT." IS staff serve as professional leaders in many ways and in many organizations.

IS has always stepped up as the technological leader in the higher education community. IS staff participate in, contribute to, and often play key (formal) leadership roles in various IVY+ and Internet2 groups, the Common Solutions Group (CSG), the Boston Consortium, the Internet Engineering Task Force (IETF) security and calendaring standards groups, CREN, Syllabus, the New England Information and Technology Managers Group (NEITMG), the 5E Private Owners Association (5EPSOA), among others. In addition, staff provide advice on a regular basis to corporations such as Microsoft, Apple, Dell, Lucent, @Stake, and Akamai via membership on corporate advisory boards or through on-going consulting relationships. IS staff also collaborated with a wide range of vendors and outside groups, apart from the higher education community, on technology development.

This past year, IS staff also contributed to EDUCAUSE publications and a collaborative cross-university white paper evaluating Apple's new operating system, MacOS X. They also acted as reviewers for NSF proposals, and as

designers and prototypers of warehouse data for the Association of American Universities Data Exchange. Several senior IS leaders were keynote speakers at conferences around the world, including the National Learning Information Infrastructure of EDUCAUSE, and the Association of Pacific Rim Universities in Kyoto, Japan.

IS staff pursue professional certifications, and IS has sponsored Windows NT and Windows 2000 courses (in direct response to the IS Customer Satisfaction Survey) to encourage others at MIT to also pursue Microsoft certification.

Perhaps the most timely example of IS's technological leadership is IS's Network Security Team, which published the first analysis of a significant new distributed denial-of-service program called "trinity," then worked with the CERT and FBI to provide information to the wider community. Closer to home, the Network Security Team hosted "Security Camp 2000," a cooperative educational/contact effort for area university security staff last year (details can be found online at http://web.mit.edu/net-security/Camp/archive.html) with such success that a second event, "Security Camp 2001," will be held at MIT on July 20, 2001, with a companion day to be held at Boston University in early March 2002.

This past year saw an interesting development in that IS's organizational framework and work processes are also increasingly viewed as leading-edge. This past year, IS's HR Practices were recognized as "best practices" by EDUCAUSE. In addition, Brandeis University, the University of Rochester, and Syracuse University all sought information about IS's Discovery Process; IS staff provided Discovery seminars and information to all three institutions.

Within MIT, IS's project management expertise continues to attract other MIT organizations who wish to develop project management capability within their own staffs. This year, Discovery project managers provided coaching and mentoring across MIT; of special note was the coaching for the MIT Libraries 3rd Barton Project. IS staff also participated in two important alumni-related initiatives. The first was the MITCET-chartered Alumni Engagement Team, which recommended ways to deepen alumni participation in the educational mission of MIT. The second was the Alumni Association's intense planning effort to become a more "web leveraged" organization. Both of these have already seen results. The Support Process continued to foster the technical skills of the departments, laboratories, and centers' "local technology experts" by sponsoring many user groups on campus, including the Macintosh, Windows, and IT Partners groups.

IS is proud of its achievements over the past year and is committed to moving forward and continuing to improve in each of these areas in the coming year.

More information about Information Systems and its work may be found online at http://web.mit.edu/is/.

James D. Bruce

VICE PRESIDENT FOR RESOURCE DEVELOPMENT

Resource Development develops philanthropic financial resources to support MIT's academic, research, and educational activities. Very broadly, we engage six constituencies in this process: corporations, foundations, major gift individual donors, principal gift individual donors, planned giving donors, and non-alumni donors. Our efforts to attract private support from these constituencies rely heavily on the support of research and systems, communications and donor relations, finance and administration, and strategic program development. Resource Development's long term strategic goal is to develop the collective philanthropic capacity of our constituencies to sustain a level of giving of at least $200 million annually in cash by 2004. The success of the $1.5 billion Campaign for MIT is critical to this goal because it not only focuses the Institute on the most important priorities for the future, but it engages and challenges our donor constituencies to understand their role in shaping MIT's future. Our ability to succeed in both of these arenas in the near and long term will not only depend on how we identify, engage, and solicit our current constituencies, it will depend on how we develop new markets, constituencies, and initiatives—all while maintaining and sustaining the best staffs possible.

As the Campaign for MIT reached the mid-point this year, as is typical of campaigns at midlife, we experienced a strategic sea change. While the early years focus on attracting lead gifts in the seven, eight, and nine figure range, it is during the middle years that the base for future philanthropy beyond the campaign is broadened and strengthened. Despite a few ripples in an otherwise rosy economy, the Campaign for MIT has not only remained well ahead of schedule, giving in the five and six figure ranges has continued to grow steadily. At fiscal year end, the Campaign for MIT stood at $1.25 billion. With three years remaining, we have raised over 80 percent of the $1.5 billion goal.

Equally important to our organizational success is our ability to maintain a client orientation, collaborate across institutional silos, emphasize sustainability in our work, and professionalism and accountability in our performance.

Resource Development continues to cultivate philanthropic relationships targeted to key institutional priorities by carefully listening and understanding the needs of our clients—be they corporations, foundations, alumni, volunteers, faculty, labs, departments, centers, MIT's senior officers, or administrative staff across the Institute. Not only is client feedback a standard part of all donor related educational programs, web-based and written communications, it is integral to the fabric of how we conduct our business.

Collaboration is critical to effectively generate private support for needs across the Institute. Resource Development works closely with the development efforts in each school to identify, cultivate, and solicit prospects, market initiatives, and support the professional development of the school based development officers. We partner with the Alumni/ae Association to sustain and maintain the alumni database of record, ADONIS, and conduct alumni/ae surveys. Administratively, Resource Development has contributed to the Institutional efforts to develop and implement best practices in financial administration and human resources.

Resource Development works to sustain ongoing and increasing philanthropy from our constituencies through targeted stewardship programs and relevant, personal communication and engagement. Since the staff serve as facilitators and liaisons in cultivating these important institutional relationships, staff retention is a critical component to sustainability. We encourage long term staff retention with careful attention to industry salary standards, and an emphasis on professional development and growth on the job.

The Resource Development staff is highly respected by our colleagues in the development field. In the last two years we have been repeatedly honored by CASE, the Council for Advancement and Support of Education. In addition to receiving the 2001 Circle of Excellence Award for Educational Fundraising, we also received The Circle of Excellence Award for Performance. Two publications, The X and Y Campaign Case and the brochure for Graduate Fellowships were also acknowledged with the Circle of Excellence Award. Our staff continue to serve as featured speakers and presenters at a variety of professional conferences including: CASE, NEDRA (the New England Development Research Association), the IVY/MIT Stanford Conference and constituent conferences, AAAS, (American Association for the Advancement of Science), The First Annual Naval-Industry R&D Partnership Conference, Product Advisory Groups for ADVANCE software.

ACCOUNTABILITY

The work of Resource Development directly effects the Institute's bottom line. Every month the Executive Committee of the Corporation reviews the monthly private support totals and overall progress of the campaign. Quarterly, the MIT Corporation and the Campaign Steering Committee do the same. Not only do we annually review and update job descriptions and measure employee accomplishments and progress toward goals in the annual

departmental performance review process, as a department our efforts are regularly reviewed and adjusted to guarantee success.

Private support for FY2001 totaled $200.8 million and included: $192.7 million in gifts, grants, and bequests, and $8.1 million in support through membership in the Industrial Liaison Program. The total compares with $233.6 million in 2000, $209 million in 1999, $143.9 million in 1998, and $133.6 million in 1997. Gifts-in-kind for the past year (principally gifts of equipment) were valued at $6.2 million. By source, gifts from alumni totaled $62.7 million; non-alumni friends: $15.9 million; corporations, corporate foundations, and trade associations: $53.1 million; foundations, charitable trusts, and other charitable organizations: $47.3 million; and others: $13.7 million.

Expendable and endowed funds were designated as follows: unrestricted, $26.4 million; research and education programs, $87.4 million; faculty salaries, $21.3 million; graduate student aid, $17 million; undergraduate student aid, $8.8 million; undergraduate education and student life, $9.7 million; building construction funds, $20.5 million; and undesignated, $1.6 million.

During the year, Resource Development promoted three women and two men. Twenty-one open staff positions were filled, including sixteen women, three of whom were African American and one Asian man. Resource Development continued its effort to recruit qualified women and minority candidates by working closely with Human Resources and others to identify new resources from which to draw its applicant pool. Key appointments include: Christine Rinaldi to Director of Donor Partnerships and Special Projects, Pamela Lomax to Director of School Development Services, and Rachel Hayes to Director of Communications and Marketing in Corporate Relations.

Barbara G. Stowe

CALCULATED RISKS, CREATIVE REVOLUTIONS: THE CAMPAIGN FOR MIT

In year four of this seven-year effort to raise $1.5 billion, the Campaign for MIT crossed the mid-point and continued to reach out to the broader alumni/ae body while working to develop support from new constituencies. Following on the heels of last year's extraordinary seven, eight, and nine figure gifts—ringing up record setting fundraising totals—this year was characterized by more modest growth overall, but significant growth in five and six figure gifts and good progress in raising support for key campaign initiatives.

At fiscal year end, the campaign total stood at $1.25 billion, well ahead of schedule. When measured across key campaign priorities, MIT raised: $163.7 million for faculty chairs; $84.7 million for scholarships and other undergraduate aid; $46.8 million for undergraduate education and student life; $114.1 million for graduate fellowships; $433.4 million for research and education programs; $258.5 million for construction and renovation; $120.1 million for unrestricted purposes; and $33 million remains undesignated.

As detailed later in this report, three areas of emphasis were key to our efforts to broaden the base and explore new constituencies. Our partnership with campaign volunteers in the Campaign Steering Committee, the Corporation Development Committee, and the Campaign Network helped bring the campaign to alumni/ae in regions across the country. Our partnership with the development efforts in each of the schools helped define and market key academic and research initiatives in need of private support. And finally, our targeted approach to cultivating and educating alumni about the philanthropic potential of life income giving and our efforts to identify and cultivate non-alumni in our Donor Partnerships program are important investments to develop these two constituencies for future philanthropy.

Stephen A. Dare

OFFICE OF PRINCIPAL GIFTS

The Office of Principal Gifts (OPG) engages the Institute's most generous individual donors, thanks them for their generosity, and encourages them to make additional multi-million dollar gifts. Under the leadership of Lucy Miller, OPG coordinates the efforts of the senior officers of the Institute and the Campaign Chairman to advance the relationships between current and future benefactors whose gifts undergird and transform MIT.

Key accomplishments this year included: negotiation of key gifts designated for core priorities including: the MITE^{2}S program, graduate fellowships, and faculty support; organization of eleven stewardship events to celebrate key campaign gifts; and support of five international trips by senior officers to continue the cultivation of international alumni and friends. In collaboration with the Offices of Campaign Giving, Donor Partnerships and Special Projects, Foundation Relations, Leadership Gifts, and the School development offices, we increased the pool of individual donors with lifetime giving of $1 million or more from 170 to 193 donors.

The Office of Principal Gifts, in collaboration with the Offices of Strategic Program Development, Campaign Giving, Leadership Gifts, Special Projects and Donor Partnerships, and Development Research and Systems continued to support the work of the Campaign Steering Committee (CSC) chaired by Campaign Chairman Ray Stata '57 EE. The CSC, a group of 16 alumni volunteer members, accepted cultivation and solicitation responsibility for 49 additional prospects bringing their active assignment total to 147.

Lucy V. Miller

OFFICE OF CAMPAIGN GIVING

The Office of Campaign Giving (OCG) cultivates, solicits, and stewards alumni and friends capable of making gifts of $50,000 or more to the Campaign for MIT. Members of the OCG field staff work closely with the senior officers, the deans and development officers of the schools, the Office of Principal Gifts and other offices in Resource Development, the Alumni/ae Association and volunteers to solicit 4000 identified prospects and donors over the course of the campaign. With each OCG gift officer responsible for approximately 150 active prospects, overall the Office manages approximately 2000 prospective donors from across the country at any given time.

As the campaign reached the mid-point, OCG focused on expanding outreach to prospects in established regions, partnering with volunteers in key markets, all while completing the transition to full staffing and continuing to train and educate a relatively new staff about fundraising initiatives and Institute culture. Key cultivation events included: technology breakfasts in New England and Silicon Valley, company-based alumni gatherings, and dinners hosted by volunteers. In collaboration with volunteers, the School of Engineering, and the Office of Communications and Donor Relations, OCG organized IdeaStream, the School of Engineering's conference for venture capitalists. OCG staff continued to identify, recruit, and deploy volunteers for the Corporation Development Committee and the Campaign Network; manage the Emma Rogers Society; and support fundraising efforts for the Arts at MIT.

David A. Woodruff

OFFICE OF GIFT PLANNING

Directed by Judith V. Sager, the Office of Gift Planning (OGP) facilitates life income giving to MIT through Unitrusts, Gift Annuities, Pooled Income Funds, and bequests. The OGP engages donors directly to encourage life income giving, in addition to supporting the efforts of the gift officers across the Institute working with prospective life income donors.

The Office of Gift Planning works closely with the Offices of Campaign Giving, Principal Gifts, and the Alumni Association to identify, cultivate, solicit, and steward planned gifts and to expand the base of donors to The Campaign for MIT. OGP hosted informative tax-wise seminars for prospective donors in Palo Alto, CA, Stanford, CT and Cambridge, MA; conducted two educational sessions for campaign volunteers, and regularly educated donors with mailings highlighting the tax benefits of specific types of gift property and gift vehicles. In the first of two marketing brochures to engage and educate prospective donors, OGP published *Ways of Giving to Support MIT* describing key life income giving vehicles and their tax benefits.

Gifts in fiscal year 2001 totaled $8.3 million. Three donors made gifts in the $500,000 to $1 million range, which accounted for 28 percent of all gifts received. Fifty-two donors made gifts ranging in size from $25,000 to $500,000.

Judith V. Sager

OFFICE OF DONOR PARTNERSHIPS AND SPECIAL PROJECTS

Established in December 2000, the Office of Donor Partnerships and Special Projects creates and sustains opportunities for long-term cultivation of non-alumni capable of significant philanthropy in support of MIT. The effort is geared toward individual philanthropists and/or their private foundations. Christine Rinaldi serves as Director.

In close collaboration with MIT's senior administrators and faculty, the offices of Resource Development, the MIT Corporation as well as other high level volunteers, identification and cultivation of non-alumni prospects were the key priority for the first six months of this program. Through these efforts, a number of gift conversations are underway.

Christine M. Rinaldi

OFFICE OF COMMUNICATIONS AND DONOR RELATIONS

The Office of Communications and Donor Relations (COMDOR) supports and enhances MIT major gift fundraising by providing editorial content, marketing initiatives, stewarding donors and planning events. Led by Laure A. Morris, the staff focused on two primary areas this year: the coordination and enhancement of stewardship and recognition efforts for campaign donors and other institutional supporters, and the development and communication of key institutional messages related to the Campaign for MIT.

Designed to keep major individual donors engaged with the Institute and informed of the impact of their philanthropy, COMDOR initiated a new program to customize stewardship for MIT's most generous donors. After reviewing existing stewardship efforts across MIT and developing a computerized tracking system in ADONIS, COMDOR collaborated with prospect managers to develop and document 450 customized stewardship plans.

The new donor recognition circle, The Catalyst Society, was launched to recognize and thank donors of $100,000 or more to the campaign with an initial 345 members inducted. COMDOR also produced annual reports on 182 individual scholarship funds and wrote approximately 1,000 personalized gift acknowledgement letters and other letters of appreciation to key donors from the Institute's senior officers.

Over two dozen events for donors, prospects, and volunteers were organized in Cambridge and throughout the country including two campus visits, and Tech Breakfasts both on campus and in northern California. COMDOR provided significant logistical and marketing support for IdeaStream, the School of Engineering's conference for venture capitalists.

Campaign communication and marketing this year included the development of an award-winning publication, *Graduate Fellowships at MIT: Attracting the Best, Inventing the Future* and a second articulating the institutional vision for campus development, *Magnetic Destinations.* The campaign newsletter, *(CR)²*, shorthand for the campaign slogan "Calculated Risks, Creative Revolutions," issued its first two editions highlighting campaign news, priorities, and donors. *Spectrum*, the 16-page human interest newsletter was honored for its excellence on both the regional and national levels by the Council for the Advancement and Support of Education. COMDOR also published several campaign working papers to build the case for support in particular priority areas, *MIT Facts 2000* and *Fast Facts*, a monthly electronic newsletter for key volunteers, alumni/ae and friends.

Of particular note this year is the increased collaboration between COMDOR and the Alumni Fund to communicate MIT's need for private philanthropic support. Two publications, *Graduate Fellowships* and *Magnetic Destinations*, were reformatted for the Alumni Fund audience and work began to combine the two existing web sites, http://web.mit.edu/campaign/ and http://web.mit.edu/giving/, into one comprehensive site to debut early in the next fiscal year.

Laure A. Morris

OFFICE OF DEVELOPMENT RESEARCH AND SYSTEMS

Led by Shelley Brown, the Office of Development Research and Systems, (ODRS), provides research, information management, technology and training support to Resource Development and its volunteers. In this fourth year of the Campaign for MIT, ODRS continued to strengthen and expand its efforts in all these areas.

Research activities continued to focus on identifying new prospects and tracking new information about existing and potential donors. With an eye toward identifying wealthy young alumni and graduate alumni, ODRS contracted with two electronic screening services to surface potential prospects through publicly reported information on company wealth, stockholdings and career success. In partnership with the Alumni/ae Association, ODRS identified hundreds of new alumni prospects and improved qualitative information about alumni attitudes toward philanthropy through the Alumni Questionnaire. In addition to standard practices of ODRS to monitor corporate initial public offers, merger/acquisitions, and professional changes of MIT associated individuals, over 500 new prospects were identified for the campaign.

ODRS also provided the initial strategic assessment and research support for the newly established program in Donor Partnerships. The office surveyed peer institutions to understand best practices for identifying and cultivating non-alumni prospects, provided research support for newly identified non-alumni prospects, and created a database to track relationships and affiliations of potential donors.

The office continued to provide traditional research support for staff and volunteers, by providing background information on and monitoring the activities of existing prospects. Reflecting the increase in campaign activity for senior officers, staff, and volunteers, ODRS prepared close to 400 prospect profiles.

The information systems staff continued an aggressive agenda to improve the accessibility and effectiveness of ADONIS (the alumni/donor database) and Macintosh desktop and network support. With the help of the Information Systems Database Group, the staff migrated ADONIS to a new, faster server. The programming staff expanded the portfolio of gift and prospect reports and implemented electronic delivery mechanisms. The Desktop/Network support team completed ahead of schedule the departmental equipment renewal strategy and delivered several training programs on software and hardware, including PowerPoint, FileMaker, Eudora, Netscape, CorporateTime, and PalmVx.

Shelley S. Brown

OFFICE OF FOUNDATION RELATIONS AND SCHOOL DEVELOPMENT SERVICES

Under the direction of John S. Wilson, the Office of Foundation Relations and School Development Services develops and strengthens relationships with the foundation community while providing development services to the Institute's five schools. Gifts from private foundations and charitable trusts for this fiscal year totaled $43.5 million and continued to provide significant support for the campaign as well as MIT's educational and research programs.

Major grants or pledges included support of OpenCourseWare; the MIT Center on Workplaces for Working Families; minority engineering fellowships; the Gender Equity Project; and Industry Studies for the Airline Industry.

The Office of School Development Services (OSDS) provided research support and project management for the fundraising efforts of the five schools, the Libraries, the Office of Academic Development, and various school-affiliated centers and labs. OSDS assisted in moving forward several of MIT's capital campaign priorities, including Health Sciences and Technology, The Arts, and the initiative for National and International Collaborations. OSDS again planned and hosted the FYI Series, which featured presentations by the Deans and various faculty members to educate the development staff on Institute and school-based programmatic initiatives.

John S. Wilson

OFFICE OF CORPORATE RELATIONS

Directed by Karl Koster, the Office of Corporate Relations (OCR), which includes the Industrial Liaison Program (ILP), creates and strengthens mutually beneficial relationships between MIT and corporations worldwide. This past year OCR upgraded numerous corporate relationships to leverage additional research and gift support, supported the efforts of the faculty for all major corporate and international partnerships, facilitated strategic linkages between individual faculty members, departments and schools and various industries. In FY2001 total corporate cash gifts to the Institute reached $53.1 million. Revenues from the Industrial Liaison Program totaled, $8.1 million reflecting an increase in the number of membership companies.

The OCR organization was realigned into three industry/technology groupings of field staff, each led by an Associate Director of OCR and an emphasis was placed on staff training and upgrading of communications and conference offerings.

OCR implemented a major corporate branding and visual system for the ILP with assistance from the outside firm of Hill, Holliday, Connors and Cosmopoulos, resulting in more than $8 million in ILP fee revenues and continued growth in the number of member companies, making this the program's most successful year since FY1991.

OCR's Faculty Liaison Plan was enhanced to provide better service to the faculty and senior administration.

More information about the Office of Corporate Relations and the Industrial Liaison Program can be found online at http://ilp.mit.edu/ilp/.

Karl F. Koster

ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT

The hallmark of the year for the Alumni Association has been our "leading with the web" initiative. Charged by our Board of Directors to use the Internet more effectively in building a worldwide community of engaged alumni, we set out to integrate the web into all aspects of our business. This initiative was approved and funded by our Board of Directors and presented to the staff in October 2000. To manage a major shift in focus to more web-leveraged activity, responsibility was placed with a process management team that included the four senior operating unit managers and the director of technical services. This team reported monthly to a web-leverage oversight group of 11 staff members. The results of our efforts are documented throughout this report.

For the sixth year in a row, I can report a record Alumni Fund result. This year marks another million-dollar plateau with Alumni Fund gifts totaling $33.07 million, placing the Fund well along the way toward a campaign goal of a $35 million fund. In a year of substantial business and market uncertainty this is extraordinary and confirms the commitment of alumni to the Institute, as well as outstanding staff work.

MIT and the Association derive tremendous benefit from our volunteer partnerships. This year I draw attention to the work of the members of the Young Alumni Campaign Committee, led by Sang Han '93 and Annalisa Weigel '94, who conducted a seminal research project on young alumni attitudes toward MIT. We needed to understand more about who these alumni are, what their attitudes are, and why their support of MIT has diminished. Our goals are to engage them in MIT's future and thereby to encourage their participation in the Alumni Fund. This study, conducted and reported online, provides MIT with a great deal of valuable and useful information.

In addition to these three highlights, the Association continued to sustain and enhance the panoply of ongoing programs, including reunions on campus, award-winning club activities around the world, and department celebrations. We celebrated the 125th anniversary of the Alumni Association with a Web-based timeline and a gala dinner in Morss Hall at Walker Memorial. We helped with the transition of *Technology Review* from an Alumni Association-sponsored magazine to a stand-alone operation still under MIT's umbrella. Significant resources continued to be directed to tightly integrating our web-based services and database with the Advance database of record.

THE INFINITE CONNECTION: THE ASSOCIATION ON THE INTERNET

The MIT Alumni Association continues to be a university leader and model for online alumni services. At a meeting of major research university alumni executives this year, I heard a consultant cite MIT for being the only web site in the group that exemplified all his standards for excellence. Our openDOOR Web magazine won both a national award for excellence and the top annual award of the prestigious Publicity Club of New England. The Council for the Advancement and Support of Education wrote in its award citation: "This site, which is described as a 'magazine' for MIT alumni, could be the best example of an alumni 'magazine' on the web...It pulls together original content with content from MIT's web site in a form that allows alumni and other friends of the Institute to connect with people and ideas."

In February, the Infinite Connection became the new name for our Alumni Network Services program. The Infinite Connection suggests the kind of lifelong connection with MIT and its alumni that we hope to foster. The Infinite Connection encompasses all our web services—the web site, Email Forwarding for Life (EFL), the Online Alumni Directory, making gifts to MIT, the Institute Career Assistance Network (ICAN), the IAP Externship program, eProNet, events registration—and more. Along with a new name, we launched new services, including new directory searches, new mailing list features, and URL forwarding. A new volunteer job opportunities web page was posted to help recruit alumni volunteers. Selected volunteers now have access to list and label data for their constituencies. The Association created a "title" email service for volunteer positions, essentially a forwarding service for positions such as alumpres@alum.mit.edu. The young alumni representative to the Corporation was elected via an online preferential voting system developed by the Association. Class Notes were published online as well as in *Technology Review*.

To draw alumni attention to the Infinite Connection, we launched our first major marketing campaign for our web services. This included a full-page advertisement in every issue of *Technology Review*, beginning in March 2001; email marketing to 8,500 alumni in the classes of 1975–2000; and a postcard mailing to 20,000 alumni targeting the classes of 1940–56 and 1983–2000. As of June 30, 2001, 38,562 alumni were registered for the Infinite Connection, an increase of 25 percent over last year. During the first six months of calendar year 2001, more alumni registered than did during all of calendar year 2000. Following the postcard mailing, the registration of older alumni nearly tripled and for the younger group, increased by about 20 percent.

Our EFL service has become the Internet address of record for many alumni, who use it for both personal and business communications. We forward nearly 2,000,000 email messages each month, an increase of 25 percent over last year. Because this service has become essential for alumni, the Association collaborated with the MIT Auditor's Office and Information Services to ask PriceWaterhouseCoopers to conduct an audit of the service. The audit confirmed that we have a robust service. The auditors made recommendations that are being implemented in collaboration with Information Services staff.

We want to use the web to celebrate our alumni —their interests, accomplishments and activities. In the summer of 2000, a Web Content Team was appointed to ensure attention to this critical element of our Internet services. Under the leadership of this group, new Association-wide web content initiatives were launched during the year. At the same time, we have placed a new focus on convergence among print, web and email to distribute key messages of the Association. During the year three communications staff people were hired to oversee this initiative. Overall traffic to the Association web site generally exceeds 50,000 hits per month.

In September 2000, openDOOR, a monthly web magazine, was launched to profile the rich diversity of intellectual activity and campus life at MIT. This magazine ties together existing material from the broader MIT web site and captures the voices of students, faculty and alumni. Topics have included entrepreneurship, the brain, art and technology. The initial issue, "The Evolving Campus," has been adopted by the MIT Office of Facilities to communicate with the community about ongoing campus construction. During its first year of publication, openDOOR averaged roughly 10,000 hits per month and more than 500 people have subscribed to the openDOOR email notification service.

In February 2001, "What Matters," an alumni guest opinion column, was launched. Each month, a different alumus or alumna contributes a column on a topic of personal interest, ranging from women in engineering to the joys and challenges of working in a foreign country. "What Matters" celebrates the range of interests and accomplishments of MIT alumni, while allowing alumni to collaborate in our web efforts.

The Association hosts 414 active email lists for alumni groups. More than half these lists were new in the 2000–2001 year. While many of these lists have been created to assist club, class, and other alumni volunteers, we have also invited alumni to use an online interface to create their own lists. Of these lists, 140 have been created by alumni, and 99 of these were new in 2000–2001. All of these lists now automatically include instructions for unsubscribing in each message. We are currently working on revising guidelines for use of these email lists and on significant improvements to the mailing list interface on the web site. In addition to these lists managed from the web site, staff members are using email to solicit alumni, to remind donors of outstanding pledges, to encourage attendance at MIT-sponsored events and to update groups of volunteers. During 2000–2001, a nine-member team, working with a consultant, has been evaluating our email communications. Recommendations for a general email newsletter to all alumni and a volunteer email newsletter are under consideration for the coming year. As email communications continue to be more central to our interactions with alumni, managing this tool effectively will be increasingly important.

The Infinite Connection includes two online career resources for alumni, the Institute Career Assistance Network (ICAN) and MIT eProNet. The ICAN mentor program now has 2,222 alumni mentors, a five percent increase over last year. Hits on the ICAN pages have increased gradually throughout the year. Alumni registered for MIT eProNet increased by 33 percent to 15,137 this year. The ProNet email marketing program this spring yielded 2,006 registrations, a 12.9 percent penetration rate.

During this year the Association launched an online service in support of club activities. Working with a vendor, ClubTools.com, we rolled out this product to 29 clubs. Even though the company eventually failed, largely due to the uncertain financial markets, we learned a great deal in this effort and are using this knowledge to continue our work toward new online services in the future.

"Leading with the web" was central to all our work during this past year. In October, we proposed five objectives to strive toward during the year:

- Increase alumni, staff, and MIT community use of Association web site and services;
- Increase self-service opportunities for online users, especially alumni volunteers and MIT staff;
- Increase use of web for marketing Association programs and services;
- Increase young alumni participation in Association programs and services; and
- Improve organizational capacity for change.

During this year, we have made significant progress toward each of these goals. Many of our efforts have been remarkably successful, and (as I predicted) a few, such as the clubs services experiment, did not work out as expected. We have collaborated with other offices at MIT and with our volunteers in an extraordinarily successful year of "leading with the web."

THE ALUMNI FUND AND THE PARENTS FUND

For the sixth year in a row, the Alumni Fund set a record for dollars raised, bringing in $33,065,675, far surpassing the goal of $31.6 million set by the Alumni Fund Board in the fall. While dollar numbers were up, the number of alumni donors is down at 28,726 for a 33 percent participation rate. The drop-off in donors is primarily among donors of gifts less than $100, attributable to changes in the *Technology Review* subscription policy as well as to the usual dampening effect of a capital campaign on donors of small gifts, not to mention a weaker economy. In addition, the uncertain business climate in 2000–2001 clearly affected donor decisions. The Parents Fund reported a 12 percent increase in gifts for a total of $458,119, from 1,049 non-alumni parents. The Alumni Fund also reports a 21 percent increase in gifts from graduate degree-only alumni, for a total of $7.05 million credited to the Fund. On

the upgrading front, we reported an increase to 6,211 alumni who were recognized in our donor recognition program, 18 percent of all donors. See the results and measurements table below for more details on fund results.

Table 1. Results and Measurements

(Note: all dollar amounts reflect the Alumni Fund $100,000 cap)

Criteria Total Alumni Fund	FY2000 Results $32.6 M	FY2000/2001 Goals -$1M	FY2001 Goals $31.6M	FY2001 Results $33.1M	FY2000/2001 Results $0.5M
Undergraduate					
# Donors to Fund	18,625	475	19,100	17,968	(657)
# Donors ≥ $500	3,510	(10)	3,500	3,507	(3)
% Donors ≥ $500	18.8%	(0.5%)	18.3%	19.5%	0.7%
# First-time Donors	705	195	900	743	38
Graduate Students Exclusively					
# Donors to Fund	10,994	306	11,300	10,758	(236)
# Donors ≥ $500	1,296	4	1,300	1,350	54
% Donors ≥ $500	11.8%	(0.3%)	11.5%	12.5%	0.7%
# First-time Donors	1,006	(106)	900	730	(276)
TOTAL					
# Donors to Fund	29,619	781	30,400	28,726	(893)
# Donors ≥ $500	4,806	(6)	4,800	4,857	51
% Donors ≥ $500	16.2%	(0.4%)	15.8%	16.9%	0
# First-time Donors	1,711	89	1,800	1,473	(238)
Total Giving ≥ $2K					
# Donors ≥ $2,000	1,386	14	1,400	628	(758)
% Donors ≥ $2,000	4.7%	(0.1%)	4.6%	2.2%	(0)
Total Giving ≥ $5K					
# Donors ≥ $5,000	727	23	750	726	(1)
% Donors ≥ $5,000	2.5%	0.02%	2.5%	2.5%	0
Parents Fund					
Total $'s	$320,000	$80,000	$400,000	$358K	38,119
# Donors	1,130	70	1,200	1,049	(81)

The reunion classes of 2001 shattered the previous total gifts record set in 1999 by presenting gifts of $75.4 million to MIT during the Technology Day luncheon on June 9, 2001. Other records reported at the luncheon included the Class of 1996 gift of $457,127 and the Class of 1961 gift of $7.29 million. The Class of 1936 presented the second highest 65th reunion gift at $23.13 million. The Class of 2001 broke records with 39 percent participation in their Senior Gift, responding to the second Fibonacci Challenge issued by Brian Hughes '77 to encourage young alumni participation. Hank Spaulding '51 announced a 50th reunion class gift of $21.72 million and Bob Lepkowski '76 reported 64 percent participation in the 25th reunion gift of $3.45 million. See the table below for reunion class results at year-end.

Table 2. Reunion Giving

Class Year	Reunion Year	Gift Total	Participation
1926	75	$5,093,980	35%
1931	70	$2,796,962	52%
1936	65	$23,135,728	74%
1941	60	$7,641,849	86%
1946	55	$390,789	41%
1951	50	$21,790,577	69%
1956	45	$1,641,640	49%
1961	40	$7,523,199	61%
1966	35	$1,186,432	54%
1971	30	$750,348	45%
1976	25	$3,473,114	64%
1981	20	$132,654	41%
1986	15	$182,886	36%
1991	10	$39,330	24%
1996	5	$458,712	21%
2001	Senior Gift	$30,899	39%
Total		**$76,269,099**	

Online giving has increased dramatically from $55,720 and 212 donors in 1999 to $360,489 and 801 donors in 2001. Online gifts more than doubled over last year with donors up 80 percent. It is encouraging to note the number of first time online gifts, also doubling over the past year and accounting this year for 6 percent of the total first gifts. A

survey of recent alumni indicated that many alumni were not aware they could make gifts online. We will do more in the coming year to promote this option, especially to this cohort.

Phonathons continued to account for close to one-third of the Alumni Fund donors (9,258) and this year raised $1.45 million. The regional phonathon in Hartford reached the $1 million cumulative mark with a celebration attended by senior Association staff members. This year the Alumni Fund decided to experiment by outsourcing some of its calling. Working with Ruffalo-Cody, a telemarketing firm specializing in non-profit fundraising, we called a test segment of young alumni nevers. These results are still being evaluated.

The Capital Campaign

The Association continues its close collaboration with Resource Development in support of The Campaign for MIT. Significant effort this year has been directed to the redesign of the fundraising Web sites; we anticipate launching a consolidated giving to MIT site before the start of the 2001 academic year. This new site will provide alumni donors and volunteers as well as MIT staff with an easy to use, information-rich site about making gifts to the Institute.

Association staff in reunion giving, the graduate alumni program and the parents program have been working with campaign staff to solicit major gifts prospects for gifts to the campaign of $50,000. Nearly 350 parents have been screened for major gifts and many "middle-donor" prospects, not likely to be solicited by campaign staff, have been assigned to Association staff for cultivation and solicitation. Reunion giving continues to be the primary area for campaign collaboration where campaign gifts account for much of the success in this year's reunion gift records.

The staff of the Alumni Fund worked closely with Resource Development to support and broaden the fund-raising messages of the Campaign for MIT through a number of initiatives. A March 2001 mailing focused on the campaign priority of graduate fellowships, and brought 242 gifts, totaling $25,395, into the Institute. A mailing for international graduate alumni sent out in April did even better, bringing in 201 gifts and $42,182. What was most remarkable about this mailing is that it garnered a 2.2 percent response rate, more than triple any previous international mailing. The Alumni Fund staff will continue to support campaign priorities in FY2002, with a planned building projects mailing, and a renewed focus on fund-raising for student life and learning initiatives.

The 18 member Young Alumni Campaign Committee, chaired by Sang Han '93 and Annalisa Weigel '94, conducted an online survey to learn about recent graduates' attitudes toward the Institute and toward philanthropy in general. Working with eDialog, a company led by an MIT graduate, the committee learned that recent graduates are generally philanthropic and that MIT is among their philanthropic priorities. Recent graduates are suspicious of the administration and want to be able to designate gifts to particular programs at MIT that they care about. Not surprisingly the committee learned that this cohort prefers email and web communications. The results of the survey were posted on the Association web site and will be used across the Institute to serve this important alumni cohort. The Committee has already used these data to design the first mailing in a series, building on the three-part theme of "Participate, Designate, Make a Difference." The second mailer in that series will drop in September.

VOLUNTEER PARTNERSHIPS

Volunteer partnerships characterize all the work we do in the Alumni Association. An examination of the work on becoming a web-enabled organization this year is perhaps the best illustration of this partnership. Responding to direction set by the Association Board of Directors, a staff Web-Leveraged Planning Committee met all summer to produce a plan and propose a budget to meet objectives outlined by the board. The Presidents Committee (the Association executive committee) reviewed these plans, approved the budget and allocated sufficient funds to supplement the reallocation of Institute resources proposed by the staff. Led by Association President Paul Rudovsky '66, the executive committee monitored our progress throughout the year. Staff and volunteers alike agree that this has been a most productive year, with many web-enabled activities implemented throughout the organization.

As the top volunteer leader, Paul Rudovsky worked tirelessly to serve MIT and the Association. He threw himself into every aspect of the job, traveling widely to visit 13 clubs and working behind the scenes on challenging assignments to bring the alumni perspective to the Institute. Rudovsky's service illustrates the fact that MIT volunteers add something to the mix that is hard to come by in any other way. More than 5,000 alumni serve MIT as volunteers in roles ranging from phonathon callers to Corporation executive committee members.

The Association recognized and celebrated this partnership at the annual Alumni Leadership Conference (ALC), held Sept. 15–16, 2000. Volunteers were invited back to campus for two days of workshops and briefings designed to help equip them for their duties on behalf of MIT. About 450 alumni and guests attended this conference and 82 percent registered online. The morning program featured an update by MIT's senior officers, moderated by MIT President Charles M. Vest HM and including Provost Robert Brown, Chancellor Larry Bacow '72, Dean of Undergraduate Education Robert Redwine, and Dean of Undergraduate Admissions Marilee Jones. The afternoon program invited attendees to learn more about the Undergraduate Research Opportunities Program (UROP) from Professor Jesus del Alamo and one of his students; to hear Dean of Student Life Larry Benedict and current student leaders present a panel on student life; and to participate in a presentation moderated by Steven Lerman '72, chair of the MIT faculty, on "Educational Transformations: What Does the Future Look Like?"

Paul Rudovsky presented the following awards, recommended by the Awards Committee and approved by the Board of Directors, during the awards luncheon on Saturday, September 16, 2000.

Bronze Beaver Award for distinguished service the MIT, the highest Association recognition honor:
Bruce A. Blomstrom '59
Hiroya Fujisaki EE'59
Brian G.R. Hughes '77
Paula J. Olsiewski CM'79

Harold E. Lobdell '17 Distinguished Service Award for sustained alumni relations service of special depth:
David Znaty SL'79
Frank L. Phillips '36
Frank T. Hulswit '49
David W. Latham '61
Frank Carroll '44
Stefan J. Garvin ML'50
Scott P. Marks, Jr. '68
Monica L. McConnell '91
G. Richard Young '37

George B. Morgan '20 Award for excellence in service to the Educational Council:
Steven Heller '43
Dale Schain Krouse '71
William J. Nicholson '60
Jack L. Rosenfeld '56
Christopher B. Whorton '65
David Wiesen '54

Henry B. Kane '24 Award for exceptional fundraising service and accomplishment:
Roger Gouldstone P'95
David E. Burmaster '69
Erin R. O'Boyle CP'85

Presidential Citation Award given to alumni volunteer groups for distinguished service:
Center for Real Estate 15th Anniversary Committee
Class of 1994 5th Reunion Committee
Sigma Chi Reunion
Student Ambassador Program
MIT Club of Washington Centennial Gala
MIT Club of Princeton

Honorary Membership (note these awards were presented at the Technology Day luncheon, June 3, 2000):
Susan H. Green
Martha H. Harleman
Diana T. Strange

The Association is responsible for the selection of 15 term-members of the MIT Corporation, three nominees each year for five-year terms. The Association National Selection Committee (NSC) nominates and recruits these alumni. The NSC is also responsible for selecting the president of the Association and its board members. The NSC has named the following alumni to MIT and Association governance positions, beginning July 1, 2001 for FY2002.

MIT Corporation for five-year terms:
Scott P. Marks, Jr. '68
Hyun-A C. Park '83,
Paul Rudovsky '66

Association president-select to serve as president FY2002:
L. Robert Johnson '63

Association vice-presidents for two-year terms:
Martin Y. Tang GM'72
Wilhelmina Fader '85

Association district directors for two-year terms:
Bruce Blanchard '57
Chiquita V. White '85
R. Gregory Turner '74
Richard R. Lowe MCP'61

Association young alumni representative for two-year term:
Ranjini Srikantiah '95

During this year 83 alumni served as members of Association national boards and committees. These committees have been led by the following volunteers: Gregory Moore '73, Alumni Fund Board; Scott Marks '68, Alumni Fund Goals Committee; Peter Saint Germain '48, Awards Committee; Robert Lepkowski '76, Committee on Nominations for Corporation Visiting Committees; Peter S. Miller '64, Enterprise Forum Board; Robert Muh '59, National Selection Committee; and Robert Summers AA '54, Technology Day Committee.

In the spring of 2001, the MIT Council on Educational Technology created a new office for Alumni Engagement under the Office of the Dean for Undergraduate Education. Working closely with this office, the Association helped identify a number of alumni who participated in several experiments involving alumni in the education of current students. Alumni mentors worked with teams of students in the class 2.009, the senior design subject in Mechanical Engineering, and with freshmen in a new subject taught by Professor Kip Hodges that investigated the question "Is there life on Mars?" Two faculty members in the physics department invited alumni to enroll in a sophomore subject on black holes, to be taught online. More than 100 alumni applied for five spots in the class. These new opportunities for alumni to volunteer for service to MIT promise to enrich and expand the possibilities for volunteer partnerships.

A major component of our staff work each year is to provide services to alumni volunteers. This year we have continued many supporting services and added new ones. We continue to provide online support for dozens of volunteer webmasters for classes, clubs, and affinity groups. Alumni Association staff writes and edits the *Alumni Volunteer News*, published in the *MIT News* section of *Technology Review*. More than 120 email lists are managed through the Infinite Connection and monitored by Association staff for clubs, classes, and affinity groups. Email newsletters are sent monthly by Association staff to club and class volunteers. Club officers workshops were held this year in Tokyo (Feb. 10, 2001), Hong Kong (Feb. 17, 2001), and Paris (March 19, 2001). New for volunteers this year is title email to allow for a smoother transition when a new volunteer assumes a position; lists and labels services for selected volunteers; an online toolkit for club officers; and online club board member training presentations. Online registration is now available for most Association events, including Enterprise Forum satellite broadcasts, the Alumni Leadership Conference, Family Weekend, and Tech Reunions and Technology Day. The Association developed an online preferential ballot for the election of the young alumni corporation member. Election tools are available for other alumni groups, and are being tested this summer by the classes of 1986 and 1996.

PROGRAMS FOR ALUMNI, PARENTS AND STUDENTS AT MIT

Many of the Association's programs take place on the MIT campus and involve not only alumni, but also students and their parents. Through these programs we give alumni an opportunity to experience the richness of our campus research and learning environment; we develop loyalty among students for a lifetime of connections to the Institute; and we give parents a glimpse of their student's MIT world.

Tech Reunions and Technology Day

Tech Reunions are the centerpiece of the Association's activities on the MIT campus. This year, over the weekend of June 7–10, 2001, 3,360 people participated in various activities associated with class reunions, Sloan School reunions and the Technology Day program. Of these, 765 were participating in Sloan activities, and 2,595 participated in Alumni Association programs.

To kick-off the celebration in Cambridge, the Association invited graduating students and their parents to join alumni for the Infinite Connection Reception to welcome our newest alumni. A record number of 50th reunion attendees from the Class of 1951 led the Commencement processional on June 8 under sunny skies. Other alumni went on tours on and off campus or checked out the MIT Museum and other exhibits on campus. Class events on Friday night attracted alumni to the Museum of Science in Boston, the Transportation Museum in Brookline, and to locations all around the MIT campus. Saturday's activities began with the Memorial Service and the Technology Day program, and concluded with the popular Great Court Gala. The 25th reunion Class of 1976 won both of Sunday's traditional events, the Reunion Row and the Tech Challenge Games. The whole celebration ended with a family barbecue event under a tent in Steinbrenner Stadium.

This year's Technology Day committee planned a program inspired by Gauguin's famous painting hanging in the Boston Museum of Fine Arts: "Where Do We Come From? What Are We? Where Are We Going?" We now possess some of the scientific and technological means to explore these eternal questions and the program explored our current understanding of these issues and their potential impact on our lives. The Technology Day program, "Origins and Beyond: Our Place in the Cosmos," was introduced by President Vest. Speakers were MIT faculty Eric Lander on "The Human Genome and Beyond"; Claude R. Canizares on "The Origin of the Universe"; and Maria T. Zuber on "Probing the Origin of the Planets from Spacecraft." The final speaker for the morning, Harvard professor Stephen J. Gould, was unable to attend for health reasons. Substituting for Gould, Charles R. Marshall, a Harvard paleontologist, spoke on "From the Fossil Record to the Genomic Revolution." The afternoon panels were "The Inner Cosmos: Language, Vision, Cognition," moderated by Samuel J. Keyser HM; "Materials and Machines:

Smaller, Stronger, Smarter," moderated by Thomas W. Eagar '72; and "Probing the Frontiers: Land, Sea, Space," moderated by Joseph G. Gavin, Jr. '41.

As a prelude to the reunions program, on Wednesday evening June 6, 2001, the MIT Enterprise Forum sponsored a panel discussion in Kresge Auditorium on "Managing a Startup in Turbulent Times." Ken Morse '68 moderated the panel, whose members included Jon Hirschtick '83, Beth Marcus '79, Fred Middleton '71 and Burt Rubenstein '76. This program was also broadcast by satellite to 16 locations around the world and 1,321 people participated.

Class reunions accounted for 76 percent of the attendance in these activities, and this year reunion classes used the World Wide Web and the Internet particularly effectively to achieve this success. All class reunion information was posted on the Web at the same time as the print materials were mailed out. The fifth and tenth reunion classes substituted a postcard mailer, pointing classmates to the Web for complete information about their plans. Each class had a web site and used email lists to update information and encourage participation; reunion attendees lists were published on class web sites. As a result, 551 of the 1,350 registrations (41 percent) came in over the Web. Online class elections were made available with two classes choosing this option. A new class officers monthly email newsletter keeps class leaders informed about what is going on at MIT and in the Association. *Technology Review* now posts class notes online. Class Programs staff and volunteers are definitely "leading with the web."

The 125th Anniversary of the Alumni Association
The Alumni Association, founded in 1875, was first led by MIT alumnus and faculty member Robert "Bobby" Richards 1868. Following the Alumni Leadership Conference, on Sept. 16 in Morss Hall at Walker Memorial, 170 alumni and guests celebrated this anniversary. Prior to the event we posted on the Association Web site a history timeline and invited alumni to add their own recollections about significant events in their MIT experiences. During the gala celebration, in a program moderated by Association President Paul Rudovsky '66, four alumni shared their own MIT memories: Joseph G. Gavin, Jr. '41, Emily V. "Paddy" Wade '45, Brian G.R. Hughes '77, and myself.

Student Programs
The Association collaborates with the offices of the Dean for Student Life and the Dean for Undergraduate Education in programming that engages students. Concluding with Senior Week activities that take place in advance of Tech Reunions, students are encouraged through these programs to make connections with alumni and to remain connected to MIT throughout their lifetimes. In collaboration with the President's House staff and the Vests, the Association again hosted Senior Dinners with 420 students and alumni attending these events on six nights at the President's House. The annual Alumni Association Expo in Lobby 10 reported 1,066 students participating in an event that introduced the services of the Association and MIT, while encouraging graduating students to register for the Infinite Connection. By year-end, 1,738 graduating students had registered for this service. A guide to Alumni Association services was sent by email to 1,935 graduates in the Class of 2000; others with no email address on record received a printed postcard referring them to the Association web site. Our Student Ambassadors program worked with 31 students who participated in 35 alumni events during the past year.

Career services are a high priority for students and recent graduates. The Association's online career mentoring service, the Institute Career Assistance Network, serves dozens of students each month who are put in touch with alumni mentors through staff in the Association office. The IAP externship program matched 81 students with 62 alumni hosts, an increase of 40 percent over last year's placements. Alumni and students use the web site to volunteer and to apply for these placements. In addition our staff collaborates with the Office of Career Services and Preprofessional Advising, including assisting with the continued development of the Freshman/Alumni Summer Internship Program in which nearly 100 students are placed in internships hosted by alumni. Our staff helped students identify alumni for career panels in fields such as medicine and allied health care, management consulting, and investment banking.

Parents Association
The Alumni Association staff works with parents through the Parents Association. In most institutions, this function is managed by the Dean's Office. The Alumni Association initiated the current parents program in the 1980s and the parents program remains with us. We work closely with the deans on programming for Family Weekend and on the publication of informational materials for parents.

Family Weekend 2000 was held on October 20–22, 2000, and was attended by 535 families and 1,740 individuals, exceeding our goals nearly nine percent. Highlights of this event were presentations by Michael Dertouzos EE '64 and Nobel Prize-winning faculty member Samuel C. C. Ting. New this year were additions to the very popular campus tours, a young siblings program, and a dinner for senior class parents. We are pleased to report 100 percent department participation this year. Nearly 45 percent of the attendees took advantage of our online registration service.

Parent volunteers are playing an increasingly important role in the Institute—351 parents served as "parent connectors" in their communities (70 new recruits this year); 16 parents were involved in Campus Preview weekend for the Admissions Office; and 29 parents served as Parents Fund volunteers. The Parents Association publishes *Parents News* once each term and a "Parents Guide" is sent to parents of incoming students. Parents Association

information is available online; a parents' email address, mykidis@MIT.edu, provides easy access to the staff for answers to questions; and registration for Family Weekend was available online this year.

Department Alumni Events
During the past year, the Association staff assisted two academic departments to produce outstanding alumni events, the Department of Aeronautics and Astronautics (Course XVI) and the Naval Construction section of theh Department of Ocean Engineering (Course XIII-A).

The Course XVI Alumni Day, "Aerospace: A Century of Accomplishment, a time of Renewal, a future of Opportunity," attracted more the 350 alumni and their guests to a two-day celebration September 13–14, 2000. This gathering celebrated the past, present and future of the department with the launch of the Learning Laboratory for Complex Systems (Building 33). Walter Frey '56 chaired a committee of 16 alumni who helped plan this two-day program that concluded with a gala alumni dinner, honoring 16 top young alumni of Course XVI. Keynote presentations were made by illustrious alumnus Professor Emeritus Robert Seamans '42 and NASA Astronaut David Scott '62.

The Naval Construction program in Ocean Engineering celebrated its 100th anniversary April 18–20, 2001. This program, attended by nearly 250 alumni, faculty and guests, featured the annual Ship Design Symposium that showcases the work of our faculty and XIII-A students and fosters positive communications between academia, industry, the Navy and the government on issues relevant to naval construction and engineering. Attendees met some of the world's top naval architects, all MIT alumni, at a gala dinner to conclude the festivities.

SERVICES TO ALUMNI WORLDWIDE

According to our database of record, MIT has 94,278 living alumni for whom we have contact information. Of these, only 19 percent live in Massachusetts and can easily participate in on-campus activities. Of the remaining 81 percent, 13 percent are international residents. A central function of the Association is to provide programs and services that bring MIT to those alumni who cannot easily make it back to Cambridge. These programs are essential to achieve our mission of helping alumni connect with one another and to MIT. For decades we have had strong regional activities and the Association continues to sustain and enhance these programs. In today's culture the Internet, and especially the World Wide Web, have become more significant as another way to provide services to alumni all over the world.

Web-based services
MITWorld, a web-based archive of Institute-sponsored lectures and events, offers alumni a glimpse of MIT, that until now, had been available only on campus. We worked in collaboration with the Center for Advanced Educational Services (CAES) to post online the presentation last fall by MIT's three Nobel economists and to market that program to alumni all over the world. Technology Day 2001 speakers will be posted on this site soon.

Most MIT clubs have posted web sites with information about their ongoing programs and some offer online event registration. The Association hosts pages for 28 clubs and affinity groups on our Alumweb server. During this year, our staff has worked with nine departments to post on department web sites pages, especially geared toward alumni of the department, steering alumni back to the Association web site for more information. "MIT On The Road" attendees may register online now and the program uses email to target marketing messages to alumni in the area where programs are offered. Our Alumni Travel program has initiated online travel journals for most trips where photos and trip reflections can be posted. Also new on the Travel Program web pages are enhanced trip information links for each program as well as links to the U. S. Center for Disease Control and U. S. consulates.

Regional Clubs and Affinity Groups
The 882 reported events offered by the 93 MIT regional clubs (50 domestic and 43 international) continue to reach large numbers of alumni and keep them in touch with the Institute. Our regional clubs program won one of two Council for the Advancement and Support of Education (CASE) alumni relations Circle of Excellence Awards for regional clubs. We were recognized for running a "model regional clubs program."

Notable activities this year included club anniversary celebrations for the Club of the Palm Beach Region (25th) in January 2001, the Club of Cape Cod (25th) in May 2001 and the Club of New Hampshire (90th) also in May 2001. The Club of Taiwan, led by Frank J.H. Liu '66, collaborated with the EPOCH Foundation to host a wonderful alumni celebration in Taipei on Jan. 18, 2001. On the program were greetings from the mayor of Taipei and a distinguished panel of alumni, including Corporation member Morris Chang '52. Paul Rudovsky '66, Association President attended each of these events. Club collaboration with the Educational Council this year increased the number of admitted-student events. In other regional programming, Parents Program events were held in northern California, New York and Boston.

The Arab Alumni of MIT (AAMIT), under the leadership of Shaheen Husain '81, hosted the second annual Pan-Arab Conference in Jordan on Feb. 19–20, 2001. It was my privilege to attend this outstanding event, along with 250 alumni and guests from more than 30 countries. Featured speakers included Michael Hawley NU '93, Lester Thurow HM, Ken Morse '68 and Khaled Toukan NU '82, His Excellency the Minister of Education of Jordan. In addition to AAMIT, the Association supports the Association of MIT Alumnae (AMITA), the Black Alumni of MIT

(BAMIT), the Chinese Alumni of MIT (CAMIT), and the Bisexual, Gay and Lesbian Alumni (BGALA). Fifty-two alumni served as officers in these groups; together they reported 1,128 members this past year.

The MIT Enterprise Forum
In its 23rd year, the MIT Enterprise Forum increased its chapters to 24 with the addition of a chapter in Greater Detroit. Local Enterprise Forum groups sponsor about 200 events each year with close to 25,000 attendees, using the efforts of 300 volunteer leaders, many of whom are MIT alumni. Twice each year we organize "best practices" meetings among these volunteers, this year October 28–29, 2000 in Cambridge and March 3–4, 2001 in Dallas.

Staff in Cambridge produces three satellite broadcasts each year before a live audience on the MIT campus and to remote sites, generally around North America. The program on October 5, 2001 featured Kenan Sahin '63, and was moderated by Howard Johnson HM. On Jan. 20, 2001 Joe Hadzima '73 moderated a panel that included Marcia Hooper, John Jarve '78, Alex Laats '89 and T.L. Stebbins. The final broadcast was a prelude to reunions on June 6, 2001, and was moderated by Ken Morse '68. Programs were received in a total of 68 locations, including Toronto, Monterrey, Mexico, and Tokyo. Total attendance was 3,733. Many of the remote broadcasts resulted from cooperative efforts of a Forum chapter, an alumni club, and in several instances, a Sloan club, with some sites signing on for all three presentations.

Alumni Seminars Program
In FY2001, 81 alumni seminars were conducted worldwide, attended by 4,490 alumni and their guests. Seventy-one faculty and MIT senior officers made presentations. Fifty-three faculty and senior administrators made presentations to 52 clubs, 39 in the U. S. and 13 abroad. The daylong MIT On The Road (MOTR) seminars typically feature lectures by four faculty members in different fields. This year more than 400 alumni and their guests attended MOTR seminars in New York City (70), Chicago (75), Palm Beach, Fla. (73), Los Angeles (132), and Paris (82). Email marketing helped to swell the ranks of attendees and online registrations accounted for 49 percent of those who participated.

Alumni Travel Program
The Alumni Travel Program had a record-breaking year with 792 travelers, a 25 percent increase over the previous year. We sponsored 35 trips, with 16 trips led by MIT faculty members. We enhanced program marketing with the second year of our successful MIT Explorer newsletter to past travelers. A committee of members of the classes of 1944, 1945, 1946 and 1950 are planning the first mini-reunion travel program. The Travel Program web pages have also enhanced the visibility of this program, which serves a niche market of fewer than 2,000 MIT travelers, many of them repeat travelers from year to year. This self-sustaining program showed a 25 percent increase in net revenue this year.

TECHNOLOGY REVIEW
In 1899, the Association of Class Secretaries founded *Technology Review*; the magazine has been a vital part of the Alumni Association's services to alumni for more than 100 years. Even so, last year it became clear to the Association leadership that the continued success of the magazine as an MIT service to a broader public required a new management structure.

During this fiscal year, arrangements have been made to establish *Technology Review* as an independent entity within MIT, no longer reporting to the Alumni Association. This concludes a seven-year effort conducted by the Association Board of Directors and the *Technology Review* Board to determine what kind of magazine *Technology Review* should become. In the spring of 2001, the magazine moved its offices from building W59 on campus to new quarters in Kendall Square, marking the end of this long history.

With the hiring of a full-time professional publisher in 1996, the magazine began a re-direction that involved the commitment of MIT financial resources as well as gifts raised from alumni to support the vision for a new magazine. The magazine staff and its board produced a growth plan for *Technology Review* to become self-supporting. The Association engaged a new editor in 1997, and with the investment of MIT resources increased the non-alumni circulation as well as advertising revenues, according to the plan. In the summer of 2000, the Association and the magazine agreed to uncouple *Technology Review* alumni subscriptions from gifts to the Alumni Fund and send the magazine to all alumni without regard to giving behavior.

At the June 2000 meeting of the Board of Directors, the Association voted in favor of the Institute's plan to spin-out the magazine as a freestanding entity within MIT. *Technology Review* will continue to publish *MIT News* as well as class and course notes as the Association's magazine for MIT alumni, under a letter of agreement outlining guidelines for this ongoing relationship. The new board of the magazine, to be appointed by the MIT president, will have a representative of the Association among its members.

SUPPORTING FUNCTIONS
The areas of information systems management, networking support, programming and systems maintenance, personnel, financial services and other operations are essential to the effective functioning of the organization. Staff in these areas work in the background and provide strong support to the many activities of the Association.

Web-Leveraged Organization
This year with the emphasis on becoming a web-leveraged organization, I created a special process management team to oversee the coordination of web-based initiatives across the organization. Members of this team are the operating unit managers and the director of technical services: Maggy Bruzelius, Director of Alumni Network Services; Beth Garvin, Director of the Alumni Fund and Class Programs; Joseph Recchio, Director of Operations, Rosemarie Resnik, Director of Alumni Activities and Geographic Programs; and Mark Jacobs, Director of Technical Services. During the year, this team has led the dramatic re-direction of much of our work to the Web, both internal and external.

In addition the Presidents Committee, by committing $500,000 of our credit card guarantee for this year to web-leveraged operations, authorized the hiring of several new positions dedicated to this effort. These new positions and positions reallocated from existing authorizations accounted for six new positions. Bruce Graber in Alumni Information Systems and Rachel Sage in Alumni Network Services were engaged to enhance our technical staffs as we moved to do more online. We created a communications convergence team and engaged Eve Downing, Andrew Skola and Jon Paul Potts (who came over from *Technology Review)* to coordinate our communications efforts, both online and conventional. Cherie Martin was employed to assist with customer service related to new clubs online services.

Other Personnel
The total headcount for the Alumni Association is 91, including one temporary employee working in Alumni Network Services, and a CASE intern assigned to Class Programs. During this year the Association saw 22 terminations or resignations and 29 new hires. There were 10 promotions in the staff this year. Paul Lingard was promoted to project director in the Enterprise Forum; Cynthia Miller to Director for Reunions; Stuart Schmill to Director of Parents and Student Programs; and Kirk Swenson to Director for Graduate Alumni Programs. In addition, the Association personnel officer continued to serve as liaison with MIT's Human Resources Office for *Technology Review* where the total headcount at year's end was 59; there were 37 new hires at *Technology Review* during this year.

Relocation to W92
On July 17, 2000, the Alumni Association underwent a major relocation with staffs of Operations and Support Services and Alumni Network Services (ANS) moving to W92. Other staff moved into space in Building 12 vacated by this move. As a result, Association staff members were located from the eastern end of the campus in E32, in the main group in Buildings 10 and 12, in W59, and in the far western end of the campus in W92. Many staff worked together to make this transition as smooth as possible, particularly those in the Operations and Support Services group who helped with planning, renovation, computer/server relocation and security. While the distribution of staff widely across the campus creates management challenges, there were some benefits, primarily locating the technical staffs in ANS and alumni information services in the same place, enhancing our ability to support the development and maintenance of online services for alumni. Other MIT technical staff is also located in W92 and it has been easier to collaborate with these offices as well.

MIT Infinite Mile Staff Rewards and Recognition
In collaboration with MIT's new staff rewards and recognition program, the Association created two new staff awards. In 1999 the Board of Directors had voted a staff award in recognition of the many years of service to the Association by Joseph S. Collins HM, who had resigned his position as Director of the Alumni Fund after 20 years. The Association Awards Committee had suggested this be an internal staff award. As we were considering how to create this new award, the Institute announced its program along with funding. We decided to make the Joseph S. Collins HM Award our top staff award in this new program and have selected an individual and a team to receive the first awards. The Association also created an Appreciation Award, which is a $25 gift certificate and can be given at the discretion of any unit manager. Any staff member may nominate anyone in any unit for these awards.

The 2002 Alumni Directory
The Association has undertaken the collection of data for the first new alumni directory since 1994. Working with Resource Development, our staff created both a paper and an online questionnaire that has been sent to all alumni for whom we have contact information. The first request for data was by email, resulting in a phenomenal response of more than 27,000, making the collection and entry of this information both less expensive and more accurate. This major database update is in preparation for publication scheduled in February 2002. To help accomplish this large task, the Association is working with an outside vendor.

Information Systems Management
During this year of web-leveraged activity, the collaboration between the ANS staff and the Association's information systems staff has been critical. We have spent enormous resource on integrating our Web initiatives with our Advance system of record. Staff from the networking and programming teams met regularly with staff representatives from across the Association in order to assess technical needs and deliver appropriate services.

During the year, the data entry team recorded nearly 50,000 gifts and pledges, and handled 7,436 credit card gifts. During this year, as the number of email addresses recorded grew to 50,248, keeping these records current became an increasing challenge. Working with ANS staff, the data entry group has developed an email bounce-back

procedure to update these important records. In addition thousands of updates need to be made to biographical and other information that we maintain for alumni and friends. Although nearly 46 percent of address updates are made by alumni online, the remaining 54 percent is still a daunting task. Eventually, we expect to see more and more updates made online by individuals updating their own records.

To provide the management information required by Association program managers, the programming staff manages thousands of production reports each month, included hundreds of ad hoc requests.

More information about the Association of Alumni and Alumnae and its activities can be found online at http://web.mit.edu/alum/.

William J. Hecht '61

Reports
to the
President

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