

Reports to the President

For the year ended
June 30, 1997

MIT Massachusetts
Institute
of Technology

Reports to the President

The *MIT Reports to the President 1996-97*
was published by the
MIT Communications Office
Public Relations Services, Room 4-237
77 Massachusetts Avenue
Cambridge, Massachusetts, 02139-4307.

Copies of the reports are available
in print and electronic formats.
For information on ordering a print copy,
call the Communications Office
at (617) 253-2635.

The publication is also available
via the Internet at the following
World Wide Web address:
<http://web.mit.edu/communications/pres97/>

For the year ended
June 30, 1997

MIT Massachusetts
Institute
of Technology

THE CORPORATION 1996-97

Chairman: Paul E. Gray
President: Charles M. Vest
Treasurer: Glenn P. Strehle
Secretary: Kathryn A. Willmore

Life Members

Paul M. Cook, Breene M. Kerr, Kenneth H. Olsen, W. Gerald Austen, Howard W. Johnson, Edward E. David, Jr., John S. Reed, Mary Frances Wagley, Emily V. Wade, Charles H. Spaulding, Shirley A. Jackson (on leave), Frank Press, Angus N. MacDonald, Raymond S. Stata, Alexander V. d'Arbeloff, Samuel W. Bodman, James A. Levitan, Alexander W. Dreyfoos, Jr., Christian J. Matthew, Morris Tanenbaum, William J. Weisz

Members

Denis A. Bovin, John M. Hennessy, Michael M. Koerner, Claudine B. Malone, Pedro Aspe, Gerald J. Burnett, Alan B. Davidson, George H. Hatsopoulos, Robert B. Horton, Nannerl O. Keohane, William B. Lenoir, Robert M. Metcalfe, Romano Prodi, William S. Edgerly, Lawrence A. Hough, Brian G. R. Hughes, David H. Koch, Ronald A. Kurtz, John A. Morefield, Jr., Robert A. Muh, Kenichi Ohmae, Darcy D. Prather, James A. Champy, Edie N. Goldenberg, Richard A. Jacobs, Judy C. Lewent, Patrick J. McGovern, A. Neil Pappalardo, Peter M. Saint Germain, Richard P. Simmons, Mark Y. D. Wang, John K. Castle, Arthur Gelb, Barbara A. Gilcrest, Mark E. Lundstrom, Antonia D. Schuman, R. Gary Schweikhardt, George N. Butzow, Josephine S. Jiménez, L. Robert Johnson, Dana G. Mead, Paul Rudovsky, Theresa M. Stone, R. Robert Wickham, Elliot K. Wolk

President of the Association of Alumni and Alumnae

DuWayne J. Peterson, Jr.

Representatives of the Commonwealth

Governor: His Excellency, William F. Weld
Chief Justice of the Supreme Judicial Court: The Honorable Herbert P. Wilkins
Commissioner of Education: Robert V. Antonucci

Life Members Emeriti

Cecil H. Green, George P. Gardner, Robert C. Guinness, Laurance S. Rockefeller, Luis A. Ferré, Semon E. Knudsen, Irénée du Pont, Jr., J. Kenneth Jamieson, John C. Haas, George W. Thorn, Ralph Landau, Carl M. Mueller, Richard L. Terrell, D. Reid Weedon, Jr., Ellmore C. Patterson, Frank T. Cary, Norman B. Leventhal, Harold J. Muckley, David S. Saxon, Colby H. Chandler, Mitchell W. Spellman, Joseph G. Gavin, Jr., Edward O. Vetter, T. A. Wilson, Louis W. Cabot

TABLE OF CONTENTS

| | |
|----------------------------------------------------------------------------------------------------------|------------|
| PRESIDENT | 7 |
| In Special Recognition | 16 |
| Statistics for the Year | 21 |
| Personnel Changes | 24 |
| Public Relations Services..... | 39 |
| PROVOST | 46 |
| Center for Advanced Educational Services..... | 48 |
| Center for Archaeological Materials/ Center for Materials Research in Archaeology and Ethnology | 55 |
| Council on Primary and Secondary Education | 56 |
| Facilities Use Committee | 59 |
| Office of Educational Opportunity Programs | 60 |
| ASSOCIATE PROVOST | 63 |
| ASSOCIATE PROVOST FOR THE ARTS | 68 |
| List Visual Arts Center | 70 |
| MIT Museum | 72 |
| Museum Loan Network Program..... | 75 |
| Office of the Arts | 76 |
| DEAN FOR UNDERGRADUATE EDUCATION AND STUDENT AFFAIRS | 82 |
| Bursar's Office | 84 |
| Registrar's Office | 85 |
| Student Financial Aid | 86 |
| Student Information Systems | 88 |
| Undergraduate Academic Affairs | 89 |
| Admissions Office..... | 92 |
| Career Services and Preprofessional Advising | 94 |
| Counseling and Support Services | 96 |
| Office of Minority Education..... | 97 |
| Campus Activities Complex | 99 |
| Athletics, Physical Education, and Recreation Department | 102 |
| MIT Card, Housing and Food Services | 103 |
| ROTC Programs..... | 105 |
| Residence and Campus Activities..... | 108 |
| VICE PRESIDENT FOR RESEARCH AND DEAN FOR GRADUATE EDUCATION | 118 |
| Graduate Education Office | 118 |
| Whitaker College of Health Sciences and Technology..... | 122 |
| Center for Biomedical Engineering | 124 |
| Center for Environmental Health Sciences..... | 125 |
| Division of Comparative Medicine | 128 |
| Division of Toxicology | 129 |
| Harvard-MIT Division of Health Sciences and Technology | 132 |
| Clinical Research Center | 138 |
| MIT/Woods Hole Joint Program in Oceanography | 142 |
| Technology Licensing Office | 143 |
| Center for Materials Science and Engineering | 144 |
| Energy Laboratory | 149 |
| Francis Bitter Magnet Laboratory..... | 154 |
| Haystack Observatory | 159 |

| | |
|-------------------------------------------------------------------|------------|
| Nuclear Reactor Laboratory | 163 |
| Operations Research Center | 167 |
| Plasma Science and Fusion Center | 170 |
| Research Laboratory of Electronics | 178 |
| Sea Grant College Program..... | 182 |
| Technology and Development Program | 187 |
| LIBRARIES..... | 189 |
| Public Services | 192 |
| Collection Services | 194 |
| Technology Planning and Administration | 197 |
| LINCOLN LABORATORY | 199 |
| SCHOOL OF ARCHITECTURE AND PLANNING..... | 206 |
| Department of Architecture..... | 209 |
| Program in Media Arts and Sciences | 213 |
| Department of Urban Studies and Planning..... | 215 |
| Center for Advanced Visual Studies..... | 220 |
| Aga Khan Program for Islamic Architecture | 221 |
| Center for Real Estate | 224 |
| Media Laboratory..... | 226 |
| SCHOOL OF ENGINEERING | 231 |
| Department of Aeronautics and Astronautics | 234 |
| Department of Chemical Engineering..... | 244 |
| Department of Civil and Environmental Engineering | 251 |
| Department of Electrical Engineering and Computer Science | 257 |
| Department of Materials Science and Engineering..... | 262 |
| Department of Mechanical Engineering | 273 |
| Department of Nuclear Engineering | 278 |
| Department of Ocean Engineering..... | 284 |
| Artificial Intelligence Laboratory | 290 |
| Biotechnology Process Engineering Center..... | 292 |
| Center for Innovation in Product Development..... | 297 |
| Center for Technology, Policy, and Industrial Development | 298 |
| Center for Transportation Studies..... | 303 |
| Concourse | 307 |
| Industrial Performance Center | 308 |
| Integrated Studies Program..... | 310 |
| Laboratory for Computer Science..... | 311 |
| Laboratory for Electromagnetic and Electronic Systems | 314 |
| Laboratory for Information and Decision Systems..... | 319 |
| Laboratory for Manufacturing and Productivity | 325 |
| Leaders for Manufacturing Program..... | 389 |
| Materials Processing Center | 327 |
| Microsystems Technology Laboratories..... | 332 |
| Program in Environmental Engineering Education and Research | 334 |
| Program in Polymer Science and Technology | 338 |
| System Design and Management Program | 339 |
| Technology and Policy Program..... | 340 |
| Technology, Management and Policy Program | 341 |
| SCHOOL OF HUMANITIES AND SOCIAL SCIENCE | 343 |
| Department of Economics..... | 353 |

| | |
|----------------------------------------------------------------|------------|
| Department of Humanities | 356 |
| Anthropology | 356 |
| Foreign Languages and Literatures | 357 |
| History | 360 |
| Literature | 362 |
| Music and Theater Arts | 364 |
| Program in Writing and Humanistic Studies | 366 |
| Department of Linguistics and Philosophy..... | 367 |
| Department of Political Science..... | 369 |
| Program in Science, Technology, and Society | 373 |
| Center for International Studies | 377 |
| Women's Studies Program | 383 |
| SLOAN SCHOOL OF MANAGEMENT | 387 |
| Education | 388 |
| Research Centers and Groups | 393 |
| Administration and Services | 397 |
| SCHOOL OF SCIENCE | 403 |
| Department of Biology | 405 |
| Department of Brain and Cognitive Sciences..... | 408 |
| Department of Chemistry..... | 411 |
| Department of Earth, Atmospheric, and Planetary Sciences | 413 |
| Department of Mathematics..... | 418 |
| Department of Physics | 420 |
| Center for Learning and Memory | 426 |
| George Russell Harrison Spectroscopy Laboratory..... | 428 |
| George R. Wallace, Jr. Astrophysical Observatory | 431 |
| Experimental Study Group | 432 |
| Laboratory for Nuclear Science | 434 |
| Center for Cancer Research | 437 |
| Center for Space Research | 439 |
| CHAIR OF THE FACULTY | 441 |
| SENIOR VICE PRESIDENT, OPERATIONS..... | 452 |
| Audio Visual Services..... | 453 |
| Campus Police..... | 454 |
| Copy Technology Centers..... | 455 |
| Endicott House | 456 |
| Insurance and Legal Affairs | 457 |
| Physical Plant | 458 |
| Planning Office | 460 |
| Purchasing..... | 461 |
| Safety Office | 462 |
| SECRETARY OF THE CORPORATION..... | 463 |
| VICE PRESIDENT FOR FINANCE AND TREASURER..... | 466 |
| Audit Division..... | 466 |
| Office of the Controller..... | 467 |
| Controller's Accounting Office..... | 467 |
| Property Office..... | 468 |
| Lincoln Fiscal Office | 468 |
| Office of Budget and Financial Planning..... | 469 |

| | |
|----------------------------------------------------------------------------------------------------|------------|
| Office of Sponsored Programs | 469 |
| MIT Press | 471 |
| VICE PRESIDENT FOR HUMAN RESOURCES AND EQUAL OPPORTUNITY OFFICER | 475 |
| Medical Department..... | 476 |
| Training and Development | 482 |
| Disability/Accessibility Services | 483 |
| Human Resources Practices Design/Development Team..... | 484 |
| Employee Relations | 484 |
| Personnel Services | 484 |
| Labor Relations..... | 485 |
| Compensation | 486 |
| Benefits and Systems | 486 |
| Faculty and Staff Information Services | 486 |
| Benefits Administration..... | 487 |
| Family Resource Center..... | 488 |
| VICE PRESIDENT FOR INFORMATION SYSTEMS | 492 |
| Academic Computing Practice | 493 |
| Office Computing Practice | 494 |
| Voice, Data, and Image Networking Practice..... | 494 |
| I/T Discovery Process | 495 |
| I/T Delivery Process | 496 |
| I/T Service Process | 497 |
| I/T Support Process..... | 498 |
| I/T Integration Process | 499 |
| I/T Competency Groups..... | 500 |
| VICE PRESIDENT FOR RESOURCE DEVELOPMENT | 502 |
| Office of Individual Giving..... | 502 |
| Office of Principal Gifts..... | 503 |
| Office of Communications and Donor Relations..... | 503 |
| Office of Development Research and Systems..... | 504 |
| Office of Foundation Relations and School Development Services..... | 504 |
| Office of Corporate Relations..... | 505 |
| ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT..... | 507 |
| TABLES AND CHARTS | |
| Students by Course and Year, 1996-97..... | 111 |
| Degrees Awarded in September 1996, February 1997, and June 1997 | 113 |
| Women Students by Course and Year, 1996-97..... | 116 |
| Women, Foreign National and Minority Graduate Enrollment, AY 1973 to AY 1997 | 120 |
| Graduate Enrollment Fall 1997..... | 121 |
| Enrollment in Humanities, Arts, and Social Sciences Subjects 1996-97 | 349 |
| Concentrations in All Fields of the Humanities, Arts, and Social Sciences Subjects June 1997 | 350 |
| HASS Undergraduate Majors | 351 |
| HASS Graduate Students | 351 |
| HASS Minor Applications for Classes of 1997, -98, -99, and 2000..... | 352 |
| Faculty and Academic Staff Count as of October 1996 | 490 |
| INDEX..... | 513 |

PRESIDENT

The future is not some place we are going to, but one we are creating. The paths are not to be found, but made, and the activity of making them changes both the maker and the destination.

– John Schaar

As we approach the Twenty-First Century, we will be overwhelmed by the rhetoric of change. Though often overblown, this rhetoric stems from a human tendency to mark passages. Such observances can serve us well if they result in introspection, recognition of new realities, and thoughtful planning for the future. Change, whether or not associated with the approach of the new millennium, is a reality. And change brings with it new opportunities and responsibilities, many derived from advances in science and technology, and from the concomitant globalization of our communications, economies, and politics.

Much of the change we are currently experiencing seems to be bringing with it a substantial rebalancing of social responsibilities among the private and public sectors, especially in the United States. It remains to be seen how deep and long-lived this rebalancing is. To some extent, it is a matter of politics, in the narrow sense of the word, but to a greater extent this rebalancing of responsibilities is likely to flow from the deeper forces bringing about such change in our society.

What do I mean by rebalancing the roles of the private and public sectors? Two major themes of the current decade are economic competition and privatization. There is less trust in governments, and increased trust in business and market efficiency. Central planning generally has been found to fail, crumbling away with the destruction of the Berlin Wall and the Soviet State. Entrepreneurial activity is increasingly valued.

In the United States, with Congress and the Administration having pledged to balance the federal budget, many long-standing federal programs will be reduced or eliminated. For the most part, however, the needs which gave rise to those programs will not disappear, and the private sector will find itself with some new or expanded responsibilities.

Increasingly, industry will be called on to address issues of common good that extend beyond the traditional principles of market-driven efficiency and shareholder value. Industry may need to write with a more visible hand than that memorialized by Adam Smith in the days when pin factories epitomized high technology and the latest in management theory.

Research universities, too, are affected by these changing circumstances. Today, many of our faculty are developing educational and research programs based on a more direct engagement with national and international priorities. More than ever, we in the universities will be called on to create – and share – scientific and technical knowledge for the common good, and to work in new ways with industry and government in so doing.

In this report, I will trace the changing roles of industry, government, and academia in generating and sharing knowledge, particularly as they bear on two areas essential to our future: a vital economy and a healthy environment.

CREATING AND SHARING KNOWLEDGE

Our nation and world are the beneficiaries of an unprecedented reservoir of knowledge about science and technology. This reservoir has been developed and continually replenished largely by two sources – federally supported university research and education, and research conducted in the national and corporate laboratories. Federal support of university research – the keystone of the nation’s ability to advance and use new knowledge – is waning, however. Government investment in research in engineering and the physical sciences is being eroded by inflationary pressures, and even increases in the support for biomedical research have slowed to little better than the rate of inflation. There have been significant changes, as well, in the nature of corporate research. Indeed, no more profound change has occurred in large U.S. companies during this decade than the change in their R&D function, and its relation to the creation of products.

Both of these developments have deep implications for education and research in our universities. The new modes of conceiving and producing products and services must be reflected in the education of our students, especially in engineering and management. At the same time, responsibility for fundamental scientific inquiry and basic technological innovation will rest in even larger measure with our research universities.

CHANGES IN CORPORATE RESEARCH AND DEVELOPMENT

For decades, most large U.S. corporations maintained a central corporate laboratory. These usually had a campus-like environment and encouraged wide-ranging thought and exploration. Scientists and engineers in these laboratories were encouraged to play strong roles in professional societies and scientific conferences, and to publish their research findings in the professional journals.

A process essentially like university tenure was followed in selecting and maintaining the senior scientific staff. Most interactions between industry and universities were channeled through the central research laboratories, creating a flow of people and ideas.

Nobel laureate Arno Penzias, then director of Bell Labs, summarized the value of the Labs to AT&T in the early 1980s when he said “Bell Labs’ value comes from the fact that we allow enormous freedom of exploration in scientific fields as long as there is a potential application to telecommunications in the long run.”

In other words, the best corporate laboratories – Bell, IBM, GE, Xerox, Exxon, and so forth – advanced science and technology, shared most of their discoveries through the scientific literature, and also established technological advances that ultimately manifested themselves in products and processes for the company. Such laboratories gave rise to a remarkable array of transforming innovations, including the transistor, high-temperature superconductivity, the laser printer, and a host of synthetic materials.

Central laboratories also provided in-house consultation for operating divisions, which themselves often undertook research and development, with the clear emphasis on development. Indeed, some laboratories like Bell had different elements that worked directly on product development.

Most of this changed in the late 1980s and early 1990s as corporations adjusted to the new realities of global competition. Increased attention had to be paid to manufacturing processes, which in turn had to be far better integrated with design. More emphasis was placed on reducing costs, addressing customer needs and expectations, reducing product-cycle times, addressing new environmental concerns, and manufacturing and selling on a global basis. The demands of meeting these new realities caused a deeper integration of the work of corporate researchers into the specific, more immediate goals of the company. This interweaving of technical and commercial activities changed the nature of R&D. The corporate laboratory often disappeared or was altered so as to be almost unrecognizable.

These changes have been exciting and productive. New intellectual challenges have been established and met. The integration of researchers into cross-functional teams has created a new style of fast-paced, complex, and challenging work. Product development began to emerge as a new professional discipline. Most R&D that continues to be carried out in industrial laboratories is aimed more directly and strategically at enhancing companies’ product lines. New styles of targeted, and very efficient, scientific inquiry began to emerge, notably “discovery science,” whereby chemical and pharmaceutical companies, for example, attempt to optimize the search for medicines, reactions, or products with prescribed properties.

No corporation can be competitive today without the kind of focused, integrated R&D described above. However, there may be a price to be paid. Now that many of their problems in manufacturing and product development have been solved, they can compete well. The strong U.S. economy and low unemployment rate presumably stem in part from these changes. Indeed, even the Holy Grail of a balanced federal budget probably owes much more to this improvement of U.S. industries than to federal policies.

But the next round of competition is likely to be won by those who innovate, *i.e.*, those who create new ideas, products and services, those who solve new human problems and create new commerce. There is a danger that wider-ranging research has been cut back too far to sustain industrial leadership in the long run. So much local

optimization by individual companies may leave the larger innovation system impoverished by lack of broader-based research whose results are shared broadly.

IMPLICATIONS FOR UNIVERSITIES

In my view, these changes in the corporate world leave universities with dual increases in responsibility. First, we must alter our education in engineering, management and, to a lesser extent, in science as well – in order to prepare our graduates to work and lead in the new industrial world. Second, universities will have an even greater responsibility for conducting broad, basic research. Some might argue that these two responsibilities are incompatible. I do not believe that is the case, however, as long as we draw from our special strengths and work with others to address our common challenges and opportunities.

As we move ahead, I believe that there are a number of features that should be incorporated into our educational programs, particularly (but not exclusively) those in engineering:

- We must begin with the *sine qua non* that we are going to retain the rigor and the scientific basis that underlies engineering education and practice. Having said this, I believe it is time that we anchor ourselves somewhat more firmly with industry. “Anchor” may not be the right term, because we are hooking onto something that is moving in new directions very rapidly. Still, we do need to maintain much closer contact with industry as it is evolving.
- We have to de-emphasize narrow disciplinary approaches, particularly in the structure of our curricula and in the way we help students learn to think. We need to pay more attention to the context in which engineering is practiced. This sounds simple, but we are finding it very challenging. We need to give students more hands-on engineering experience, or grounding in how to “design-build-operate,” as we like to call it.
- We need to educate students to work better in teams. Do not misunderstand: Ultimately, the most important strength we have is individuals and their capacity for innovation. However, every organization that I know about accomplishes most of its work in teams because of the complexity of today’s tasks. Indeed, many teams in business and engineering today are in fact world-wide electronic communities, linked by a variety of telecommunications channels.
- We need to become more adept at preparing our students for living and working in an international environment. Globalization is not something that is coming, it is something that has already happened. Academic institutions are behind the curve somewhat in bringing this reality into our educational programs. My guess is that the key is going to be engagement – engagement by U.S. universities with organizations, governments, and industries operating in other countries. We tend to work best and learn the most when we’re actively engaged in partnerships of one sort or another.
- We have to continue developing and utilizing information technologies in education, no matter how rapidly they advance. At MIT and elsewhere, books are published and courses taught on the World Wide Web. Nonetheless, I continue to believe that we have just scratched the surface of what the new technologies make available to us in education and learning. This is a time for experimenting. It is a time for networking among U.S. universities to learn which new approaches to learning are working well and which are not.

All these changes, and others that will follow, require thought and development by dedicated faculty, but they also may require conscious involvement and support on the part of industry.

As noted earlier, the changes in the nature of research within industry will place an even larger responsibility for conducting broad, basic research with our universities. Since we generally do this very well, that is fine. However, who will be our patron? First and foremost, the federal government. There seems to be general agreement on this point across the political spectrum. Indeed, formal statements by large numbers of industry CEOs, chambers of commerce, state governors and legislators, members of Congress, and university leaders seem to indicate an effective national consensus on the importance of strong federal investment in university research. However, despite the committed leadership of key members of Congress on behalf of science and engineering research, that agreement is not translating into the increased levels of support needed to sustain this effort in the long run. Furthermore, many

in the government ask the legitimate question: if industry ultimately benefits from university research, then why are they not paying for more of it?

This is closely related to the question of why doesn't industry itself increase the long-term, basic research it conducts and contribute more to the commonly shared base of scientific and technological knowledge? The answer generally is that, in the short term, the market doesn't demand it. Furthermore, the value derived from such endeavors does not necessarily accrue to the organization that conducts research which is not directly applicable to its product line.

How do we resolve this conundrum? We might start by considering our national innovation system – and how it depends on academia, industry and government working together in new ways to sustain a vital economy.

SUSTAINING AMERICA'S INNOVATION SYSTEM

The health of our economy depends on a vigorous system for supporting innovation. America's innovation system consists of academic, industrial, and governmental institutions working together to support and generate new ideas, to educate the next generation of innovators and entrepreneurs, and to transfer the practical benefits of new scientific and technological knowledge to society.

The great public and private research universities, spread across our land, play an indispensable role in this system. Their faculties conceive and conduct the research that generates a great deal of our new knowledge, and in the process they educate the young men and women who will become the inventors, innovators, industrial leaders, company founders, teachers, and doctors of the future. Their graduate students, carrying new ideas from their research experiences as they enter the workforce, are the primary means of technology transfer from academia to industry.

This has been possible in large measure because of the wise investment by the federal government in higher education and research. Every federal dollar spent to support university research does double duty. Not only does it pay for the conduct of the research, it simultaneously supports the education of graduate students who learn as they work together with faculty on research in science, engineering, medicine, and business.

I believe we must give the highest priority to maintaining our nation's world leadership in science and technology. We must sustain the vitality of university research and education as the foundation of America's innovation system. Beyond this, we must support an innovation system that is not bound by one-size-fits-all government regulations, but thrives on a mixture of creativity, competition, and cooperation.

Meeting such a challenge holds implications for the responsibilities of both the public and private sectors. The private sector will need to take increased responsibility for contributing more to the base of shared knowledge and to better define its role in the long-term sustaining of technological leadership. The public sector must more effectively recognize both the underlying support it must provide for research and education, and its responsibility to provide a business-friendly and research-friendly tax and regulatory environment.

THE IMPORTANCE OF NEW PARTNERSHIPS

Beyond that, we must even more effectively couple university research to industry and business by building partnerships. Yet we must do so without destroying the fundamental values and culture that allow universities to serve society over the centuries, and not just at the moment.

During the last year, the Council on Competitiveness, a nonprofit group of industry, labor, and university leaders, has convened a series of bipartisan, multi-sector meetings across the country. These have brought state governors, CEOs of large corporations, university leaders, representatives of the Congress and the Clinton administration, entrepreneurs, labor leaders, directors of federal laboratories, and venture capitalists together for intense discussions about strengthening and sustaining our innovation system.

One of the most pervasive and widely accepted conclusions of these discussions is that the greatest opportunity to strengthen the U.S. system of innovation lies in an improved synergy among industry, universities, and the federal research apparatus.¹ Creating a policy environment that encourages partnerships across sectors seems to be essential. This will require attitudinal changes, mutual respect, a greater degree of openness, and purposeful

dialogue. It will work only when projects and programs are seen as mutually beneficial and when all parties are genuinely interested in the problem at hand. This generally argues that such partnerships will deal with moderate to long-term issues, and with sorting out emerging new principles underlying contemporary industrial operations and organizations.

A ground-breaking new partnership of this type is MIT's Center for Innovation in Product Development. The establishment of this center was motivated by the enormous intellectual challenge of identifying the basic principles of effective product development and the need to better educate engineers and managers to undertake the development of new products in today's fast-paced, competitive, and complex and globalized industrial world. The Center's existence was greatly facilitated and accelerated by the National Science Foundation's Engineering Research Center program. In the end, however, without the shared perception of need and opportunity among MIT and several companies, large and small, the Center would not have been possible.

Working closely with a consortium of high-level managers from Xerox, Ford, ITT, and other leading corporations, the Center will draw on MIT's unique combination of strengths in both engineering and management to conduct cutting-edge research in such topics as the better matching of technology development to the timing of market opportunities, the alignment of product-development risks with corporate capabilities, and the translation of consumer preferences into technical specifications. The Center will also develop texts and course offerings for both graduate and undergraduate students, and will make these materials available to engineers and managers working in industry.

Other emerging partnerships at MIT involve direct scientific collaboration with companies such as Amgen and Merck. These partnerships involve no federal component. They support mutually agreed-upon basic research problems at the cutting edge of modern biology and biotechnology and encourage intellectual synergy and sustained dialogue among company and academic scientists. They, too, have a strong emphasis on supporting education, at both the graduate and post-doctoral levels.

Finally, any discussion of America's innovation system must recognize the central importance of entrepreneurship and the establishment of small companies. In this era, it is such "start-up" companies that have created expanding employment. It has been the opportunity to be entrepreneurial that has allowed the U.S. economy to rapidly restructure in the wake of corporate downsizing and international pressures. Finding better ways for large companies, the government, and research universities to work with such emerging companies is the key to strong innovation and its translation into economic and social progress.

In the end, however, the single most important contribution of research universities to our innovation system is the education of men and women with an understanding of emerging new science and technologies and the creativity, mindset, and skills to apply them wisely.

A SOUND ENVIRONMENT IN A SOUND ECONOMY

Another domain in which we all have a vital stake and an inescapable responsibility is the global environment. The growth of human population and activity has fouled the air, depleted the soils, diminished the forests, and degraded our fresh waters. The consequences are immense: Three and a half million people die each year from diseases borne by unsanitary water; hunger is a fact of life for countless more; the damage to the ozone layer threatens us all; and we face the annual loss of thousands of species.

Stewarding the earth's environment will require industry, universities, and government to assume new responsibilities and to join forces in new ways.

For the past thirty years or so, environmental concerns in this country have been dominated by a mentality of government regulation and remediation. At its best, this has dramatically improved our health and quality of life. At its worst, it has led to unreasonable legalistic resolutions, adversarial decision processes, and priorities set without sound scientific or economic bases. Perhaps this was inevitable as our understanding of the issues developed within the context of a high-consumption economy and mature industrial infrastructure. Many current industrial processes were developed in an age when resources seemed inexhaustible, and when it seemed incomprehensible that the day might come when humankind's influence might substantially threaten the balance of the global environment.

Today, however, we understand that many resources are finite, that industrial development affects our air and water and perhaps our climate, and that the green revolution in agriculture has its price. What is new in all of this is our awareness of the enormous complexity of the problems and of their possible solutions. Understanding and analysis of environmental issues, and the development of innovative solutions requires a complicated interaction of basic science, engineering, economics, politics, social theory, and education.

I am optimistic that in the long run we will make great progress. Why? Because we all cherish good health and the beauty of our earth, and because this is extraordinarily rich and fertile territory for academic investigation and industry problem solving. Furthermore, many aspects of good environmental stewardship at heart involve increasing efficiency – efficiency of energy conversion, efficiency in the use and processing of materials, efficiency in transporting people and goods, and efficiency in the use of financial resources. Engineers, economists, organizational experts, and managers all value good efficiency on some plane, so working to reduce waste and environmental damage has an innate appeal to many of the key disciplines.

However, there are counter forces:

- Our political and journalistic systems are susceptible to nearly random inputs. Hence we tend to develop “issues of the day” rather than analyze and prioritize problems to the best of our ability.
- The pressures of intense competition coupled with the regulatory systems do not always lead to optimal strategies for cleaner operations and environmental improvements. Hence the investments in research and industrial infrastructure or cooperative activities that are needed for the long haul are not always made.
- Commitment at the top of organizations sometimes flags at lower levels where day-to-day pressures dominate.
- Our political system mitigates against the flow of large financial and technical resources across national boundaries for the solution of environmental problems. As a result, the disparities between the north and south, between the developed and the developing worlds, remain serious impediments to a healthy environment.

NEW ROLES AND RESPONSIBILITIES

Industry and academia must play increasingly important and synergistic roles in establishing environmental responsibility and developing effective solutions. We at MIT are working hard to establish this new paradigm – by educating engineers, managers, scientists, economists, and policy experts to analyze environmental issues and synthesize sound solutions. This does not mean only that we need to educate more environmental experts, it means that sound thinking about, and commitment to, sustainable development and environmental stewardship must be an integral part of the education and practice of engineers and managers.

Equally important is the emerging role of MIT and some other leading research universities in convening disparate parties for serious dialogue. Such discourse can help identify the key research issues, improve understanding of how governmental and industrial decisions can be informed by scientific knowledge, and make resource distribution more effective.

This approach has been enthusiastically welcomed by the corporate world, which is finding that sound environmentalism and an anticipation of its requirements is good business.

The growing commitment to a healthy environment on the part of both industry and academia is setting the stage for new partnerships between the public and private sectors. Take, for example, the Montreal Protocols on the reduction of chlorofluorocarbons in the atmosphere – in order to halt the damage to the earth’s protective ozone layer.

These protocols are based on the fundamental scientific work of MIT’s Nobel laureate and Institute Professor Mario Molina and his scientific colleagues, including Sherwood Rowland of the University of California at Irvine and Paul Crutzen of the Max Planck Institute for Chemistry in Germany. It is an agreement that rests not only on sound science, but on determined and thoughtful work across complicated political and geographic boundaries to ensure that all the citizens of the world benefit, whether they reside in rich nations or poor ones. The genealogy of the

Protocols begins with atmospheric chemistry research funded by the federal government, which led to a solid understanding among knowledgeable industry leaders, which in turn led to a political will to execute a thoughtful international agreement. In sum, three sectors played appropriate and highly interacting roles that led to improvements for all.

At MIT we are wrestling with various organizational issues to best approach these matters. As is appropriate in our intellectually diverse and entrepreneurial institution, many efforts have grown somewhat independently and are now interacting with each other.

A particularly effective example of this new approach is the MIT Joint Program on the Science and Policy of Global Change. This program has brought together the talents of faculty, research staff, and students from several disciplines, forming an integrated approach to analysis of global climate change. It is sponsored in a consortial manner by a large number of U.S. and international companies aided by governmental research support and governmental and public group participation. Central to the program's mission and effectiveness has been the Global Change Forum, which has become a very well-attended ongoing seminar among high-level scientists, executives, and decision makers from industry and government. It has met 12 times in 7 years, generally alternating between MIT and a location in another country. The Program participants are working from a common understanding and set of goals, proceeding not from the emotion that has driven much of the environmental debate and decision-making in the past, but from a base of mutual learning, research, policy analysis, and public education.

This is not to say that matters of environmental stewardship can or should be approached in a manner devoid of emotion. Emotion has a legitimate role in environmental matters. It is our ability to experience and envision the benefits of a healthy environment that signal to us the importance of environmental stewardship. And it is our ability to envision potential degradation and its effects that leads us to understand the critical necessity for preemptive action. Rational policy analysis, objective science, and sound technology, however, are the extensions of human thought and physical capability that will enable us collectively to establish and accomplish our environmental goals. In other words, *mens et manus*, MIT's mind and hand philosophy, is precisely what is called for.

Similarly, we cannot progress by ignoring economic and social realities any more than we can ignore scientific and engineering principles and realities. These provide the framework in which the new responsibilities and opportunities for business and industry emerge. On one plane, business exists to create wealth and to provide for the financial advancement of its shareholders. Of course, on a deeper plane, business exists to advance the human condition. These enterprises produce clothing, shelter, and food, and provide healthcare, entertainment, and all manner of services. The markets distribute our wealth, provide incentives for productive activity, and, to a significant extent, influence how we interact with our environment and utilize the resources of the earth.

Unfortunately, markets and businesses, as conceived within the dominant value and social systems, tend to be too dominated by short-term thought and goals to create capital flows from poor to rich and south to north. There arguably is too much local and near-term optimization. But this situation can be improved. Indeed, in my view many leaders of industry are beginning to work toward long-term solutions to environmental and economic problems, and many scholars are working on new constructions that will support this, and that will work with, rather than against, markets.

SUSTAINABLE DEVELOPMENT

The concept of sustainable development is emerging as a framework for these efforts. Much of the original thinking about this concept has come from business leaders, particularly the Swiss industrialist Stephan Schmidheiny. As he wrote in a declaration prepared for the Business Council for Sustainable Development, "The world is moving toward deregulation, private initiatives, and global markets. This requires corporations to assume more social, economic and environmental responsibility in defining their roles. We must expand our concept of those who have a stake in our operations to include not only employees and shareholders but also suppliers, customers, neighbors, citizens' groups, and others.... Progress toward sustainable development makes good business sense because it can create competitive advantages and new opportunities. But it requires far-reaching shifts in corporate attitudes and new ways of doing business." ²

Sustainable development sets as a goal providing for the needs of the present generation, including the right to advance economically, while minimizing the risk to future generations' abilities to enjoy the same provision and right. It requires of us a more cooperative, interactive approach, a much longer time horizon in our thinking, a responsibility to educate ourselves about risk and efficiency, and an obligation to develop technologies that are more efficient in their overall use of resources.

Is a world of continual economic development absolutely sustainable? In the sense that this implies total and continual renewal of all resources, clearly not. Both the laws of physical nature and of economics deny us that ideal. However, we should strive to understand what levels of sustainability may be achievable, and strive to approach them in our industrial practices.

This leads to the concept of eco-efficiency. Admittedly it is a vague concept, but it is very important, nonetheless. It requires an awareness of how our systems for generating energy, producing food and goods, or transporting people and materials are intimately linked to environmental quality and sound economies. It requires examining the total flow of materials through the processes of production, use, and reuse. Such an approach could lead, for example, to locating industrial plants in such a way that the "waste" or byproducts of one may be used as the resource or raw material of another. Eco-efficiency requires a significant base of research, development, and innovation. Above all, it requires a longer vision and a more integrative style of thought and analysis than we are used to.

This vision and style must be driven not only by concern for our fellow humans, present and future, but by pragmatism and hard-nosed analysis. As environmental awareness and concern become more prevalent, increased efficiency and improvements in "cradle to grave" utilization of natural materials is becoming good business. If the importance of sustainable development becomes increasingly influential in setting our societal goals, sound environmental stewardship will become even better business.

Indeed, I believe that business and industry is likely to lead our movement toward more sustainable development and improved environmental stewardship. We are beginning to see the necessary proactive yet pragmatic business leadership emerging in several global corporations.

Education and understanding are key to setting and effecting such an agenda. If the world's educational institutions, and particularly our research universities, increasingly focus on the issues of sustainability and resource management, we can assure that more knowledge is gathered, developed, and shared about these issues. MIT, the University of Tokyo, and the Swiss Federal Institutes of Technology in Zurich have joined together for just that purpose by forming an Alliance for Global Sustainability. We do so in the conviction that universities around the world can make a profound difference in how their societies think and act on the question of global sustainability. The result will be better business and a better environment.

IN CONCLUSION

Ours is a dynamic society, continually redefining its agenda and the relative roles of its players. But some things are so basic to our welfare as to transcend temporal shifts in priorities. A vital economy and a healthy environment are two such fundamentals. They are not incompatible. Working together, universities, industry, and governments can find ways to sustain a sound environment *and* economy.

For universities, this is an exciting time – a time of rapidly expanding knowledge, of engaging even more directly with activities that are vital to the common good, and of working in new ways with industry and government to achieve these goals. We are creating new paths as our relative responsibilities come into a new balance, but one thing is clear: we are all stewards of the future.

Charles M. Vest
September 1997

NOTES AND ACKNOWLEDGMENTS

I would like to recognize the work of MIT's Council on Industrial Relationships and Council on the Environment, whose work and interviews with leaders from all sectors have been most helpful in forming my personal views on these subjects.

1. *A Call to Action – 1997 Regional Summits on American Innovation*, Council on Competitiveness, 1401 H Street, NW, Washington, D.C. 20005.
2. Schmidheiny, Stephan, *Changing Course: A Global Business Perspective on Development and the Environment*, MIT Press, 1992, page xii.

IN SPECIAL RECOGNITION

Over the past year, the MIT community experienced a number of noteworthy changes in its academic and administrative leadership.

The most notable was the decision by Paul E. Gray to relinquish his role as Chairman of the MIT Corporation, a position he had held since 1990. His achievements as chairman cap a lifetime of unparalleled service to the MIT community. After earning three degrees from MIT, Dr. Gray began his teaching career here in 1960 as an assistant professor of electrical engineering. He advanced quickly through the faculty ranks, assuming a number of challenging administrative roles as well. In 1971, Dr. Gray was named Chancellor, and in 1980 became MIT's fourteenth President. He continues his service to the Institute as Professor of Electrical Engineering and Life Member of the Corporation, which has also accorded him the special title of Honorary Chairman. A wise, passionate, and dedicated leader, Paul Gray remains one of the most effective advocates for the interests of the undergraduate community, which he describes as "our future and our legacy to the world." While his title may have changed, he continues to be what he has always been – one of the Institute's most valued leaders and one of its best-loved citizens.

Alexander V. d'Arbeloff, co-founder and chairman of Teradyne, Inc., was elected by the MIT Corporation to succeed Dr. Gray as Chairman. A member of the Corporation since 1989, and Life Member since 1994, Mr. d'Arbeloff '49 has also taught at the Sloan School of Management and in the Department of Mechanical Engineering. He brings to his new job a wide-ranging knowledge of high-technology industries, a solid understanding of MIT, the admiration of the Institute's faculty and staff, and extraordinary levels of energy and intellect.

Professor Lawrence S. Bacow of the Department of Urban Studies and Planning completed a highly productive two-year term as Chair of the MIT Faculty. Professor Bacow brought to his work energy, wisdom, diplomatic skill, and understanding of process, as well as an interest in all segments of the Institute community. He is succeeded as Faculty Chair by Professor Lotte Bailyn of the Sloan School of Management, an expert in the relationship between managerial practice and employee lives.

Kip V. Hodges, Professor of Earth, Atmospheric and Planetary Sciences, was appointed Dean of Undergraduate Curriculum. Professor Hodges will play an important role in shaping the newly reorganized Office of the Dean of Students and Undergraduate Education.

John S. Wilson, Jr., Director of Foundation Relations and School Development Services, was named to the new additional position of Assistant Provost for Outreach. He will work to strengthen and expand MIT's connections to students and faculty at historically black colleges and other institutions. Dr. Wilson also serves as associate housemaster at MacGregor Hall.

New academic department or program leaders whose service began during the year were Stephen A. Benton, Director, Center for Advanced Visual Studies; Michael M. J. Fischer, Director, Program in Science, Technology, and Society; Robert M. Freund, Co-Director, Operations Research Center; Alex Paul Pentland, Head, Program in Media Arts and Sciences; and Stephen R. Tannenbaum, Head, Toxicology Program in the Whitaker College of Health Sciences and Technology.

Among key changes in the administration during the past year were the appointments of Bruce N. Anderson as Director of Industrial Relations; Bruce M. Bernstein as Director, Publishing Services Bureau; Stefano Falconi as Director of Budget and Financial Planning; Arnold R. Henderson as Section Head, Counseling and Support Services; Patrick W. Fitzgerald as Director of Cost Analysis; and James L. Morgan, III, as Controller.

Marilee Jones, Associate Director of Admissions, was named Interim Director of Admissions while a special committee began a search for a permanent successor to Dean of Admissions Michael Behnke, who left MIT for the University of Chicago. Elizabeth A. Reed was named Interim Director of Career Services and Preprofessional Advising, following the retirement of Robert K. Weatherall, who had led the office since 1969.

As the year began, a number of reporting relationships within the administration were realigned. The Office of the Dean for Undergraduate Education and Student Affairs assumed oversight of Admissions, Athletics and Physical Education, the Bursar's Office, the Campus Activities Complex, Career Services and Preprofessional Advising, Housing and Food Services, the Registrar's Office, Student Financial Aid, and Student Information Systems. The inclusion of these activities in "the Dean's Office" unified the broad range of student services in a single organization, which was renamed the Office of the Dean of Students and Undergraduate Education to reflect the expanded scope of activity.

The Office of Sponsored Programs began to report to the Vice President for Finance and Treasurer, while the Medical Department began reporting to the Vice President for Human Resources.

* * *

The faculty and staff of the Institute continued their tradition of high achievement and great distinction. The summaries which follow touch on only some of the honors bestowed on members of the MIT community during the past year.

Dr. Robert A. Weinberg, Daniel K. Ludwig Professor for Cancer Research in the Department of Biology, an American Cancer Society Research Professor, and a founding member of the Whitehead Institute for Biomedical Research, received the National Medal of Science for his pioneering achievements in understanding the genetic basis of human cancer. Dr. Weinberg led the research teams which identified the first known cancer-causing gene as well as first recognizing a tumor-suppressor gene, thereby paving the way to a whole new branch of research based on the recognition that cancer may be understood – and ultimately treated – as a result of genetic coding gone awry. The total of MIT faculty members to have received National Medals of Science or Technology now stands at 21.

One of MIT's most illustrious and generous benefactors, Mrs. Vera List, was awarded the National Medal of the Arts for her extensive philanthropy in support of art and the humanities at MIT and many other institutions. The List Visual Arts Center, the List Center Endowment Fund, the List Foundation Fellowship in the Arts, and the Institute's Writing Prize all owe their existence to gifts provided by Mrs. List in conjunction with the Albert A. List Foundation.

In recognition of their exceptional leadership, accomplishment, and service in the scholarly, educational and general intellectual life of the Institute and of the wider academic community, three professors were named Institute Professor, a title the Institute reserves for about a dozen faculty members of particular distinction. They are Peter A. Diamond, Paul A. Samuelson Professor of Economics; Thomas L. Magnanti, George Eastman Professor of Management Science and Co-director of the Systems Design and Management Program; and Mario Molina, Professor of Chemistry, and Lee and Geraldine Martin Professor of Environmental Studies in the Department of Earth, Atmospheric and Planetary Sciences.

Three members of the MIT faculty were elected to the National Academy of Sciences (NAS): Sylvia T. Ceyer, John C. Sheehan Professor of Chemistry; and Professors of Biology Peter S. Kim and Eric S. Lander. These elections bring to 107 the number of MIT faculty named to NAS membership, one of the highest distinctions accorded within the scientific community.

The Institute of Medicine (IOM) also elected three MIT faculty to its ranks: Gerald R. Fink, a professor of medical genetics in the Department of Biology and director of the Whitehead Institute for Biomedical Research; Mario Molina, whose research on the effects of man-made chemicals on the ozone layer earned him a 1995 Nobel Prize; and Steven R. Tannenbaum. The addition of Professors Fink, Molina, and Tannenbaum brings to 24 the number of MIT faculty among the IOM's 545 active members.

Thomas W. Eagar, POSCO Professor of Materials Engineering, and Henry M. Paynter, Professor Emeritus of the Department of Mechanical Engineering, were elected to membership in the National Academy of Engineering (NAE), bringing the number of active and emeriti/ae Institute faculty in the NAE to 90.

Four MIT faculty members were inducted into the American Academy of Arts and Sciences: Ronald Latanision, Professor of Materials Science and Engineering, Director of the H.H. Uhlig Corrosion Laboratory, and Chairman of the Council on Primary and Secondary Education; William J. Mitchell, Dean of the School of Architecture and Planning; Tomaso Poggio, Uncas and Helen Whitaker Professor of Brain and Cognitive Science; and Elizabeth Spelke, Professor of Brain and Cognitive Science.

Associate Professor Michael Kremer of the Department of Economics was designated by the John D. and Catherine T. MacArthur Foundation as a 1997 MacArthur Fellow. Professor Kremer was given this coveted honor – known familiarly as the “genius grant” – for his work on wage inequality, differential rates of economic growth and development in emerging economies. He was also recognized for his accomplishments as a founder of WorldTeach, an organization that supplies teachers to developing regions and has offices in ten countries worldwide.

Continuing the Institute’s tradition of national service, several members of the faculty were given significant appointments by the federal government. Institute Professor David Baltimore, 1975 Nobel laureate in medicine and Cottrell Professor of Molecular Biology and Immunology, was named to head the AIDS Vaccine Research Committee of the National Institutes of Health. Separately, as the year came to an end it was announced that Professor Baltimore would leave MIT in the autumn to become the President of the California Institute of Technology. Professor Daniel Hastings of the Department of Aeronautics and Astronautics was named Chief Scientist of the U.S. Air Force. Professor Phillip A. Sharp, Nobel laureate and head of the Department of Biology, was appointed to the National Cancer Advisory Board. Laurence R. Young, Apollo Program Professor of Astronautics, was appointed Director of the new National Space Biomedical Research Institute of the National Aeronautics and Space Administration.

Three members of the faculty were appointed MacVicar Faculty Fellows in recognition of their outstanding personal achievements as teachers and their dedication to the development of teaching excellence throughout the Institute. The new fellows are John M. Essigmann, Professor of Chemistry and Toxicology; Lowell E. Lindgren, Professor of Music; and Alan V. Oppenheim, Professor of Electrical Engineering.

Robert S. Langer, Germeshausen Professor of Chemical and Biomedical Engineering, was awarded the 26th annual James R. Killian, Jr., Faculty Achievement Award. The selection committee cited Professor Langer for his leadership in the development of polymeric drug delivery systems that allow humans to receive drugs in a physiologically normal manner and his contributions to the field of tissue engineering.

Julie Dorsey, Associate Professor of Architecture, was named recipient for 1997-98 of the Harold E. Edgerton Faculty Achievement Award, which recognizes junior faculty members for distinction in teaching, research, and service to MIT. Professor Dorsey was recognized by the selection committee for a body of work which has advanced the science of computer graphics while furthering the practice of architecture with a rare combination of technical and artistic expertise.

The Gordon Y Billard Award, recognizing individuals who have performed special services of outstanding merit to MIT, went to Rolf Engler, Administrative Officer in the Department of Urban Studies and Planning, and Paul Thomas, Technical Supervisor in the Plasma Science and Fusion Center. Mr. Engler has won the respect and affection of faculty, students, and staff alike through a combination of efficiency, service, professionalism, and compassion. Since 1992, Mr. Thomas’ classroom demonstrations on magnetism and electricity have brought science to life and earned him the title among Boston schoolchildren of “Mr. Magnet.”

* * *

The Institute noted with regret and fond memory the passing during the year of former colleagues.

Herbert L. Beckwith, an alumnus and Professor Emeritus, was an accomplished architect who designed the Alumni Pool, Rockwell Cage, and nine other Institute buildings. In a career which spanned five decades, he brought modern architecture to MIT, founded a successful design firm, and served as acting Head of the Architecture Department. The designer of such notable buildings as the U.S. Embassy in Tokyo, he also acted as associate to Eero Saarinen in

the development of Kresge Auditorium and the Chapel. He died June 3, 1997, at his home in Kingston, Massachusetts, at the age of 94.

Joseph Bicknell, Emeritus Professor of Aeronautics and Astronautics, died in Kingman, Arizona on July 22, 1996, at the age of 84. Professor Bicknell served on the faculty for thirty years and was instrumental in developing the Wright Brothers Wind Tunnel and testing aircraft designs there during World War II. Throughout his MIT career, he was a member of the Sailing Club and pursued a hobby in small-boat design, construction and repair. In retirement on the island of Port Aransas, Texas, he continued to work with small boats, while playing a key role in developing the community's first library and serving as a substitute teacher in the public schools.

Gordon S. Brown, Institute Professor Emeritus and Dean of the School of Engineering from 1958 to 1969, died in Tucson, Arizona on August 23, 1996. A pioneering electrical engineer and one of the most important figures in twentieth-century engineering education, Dr. Brown died two days before his 89th birthday. A native of Australia and MIT graduate, he joined the faculty in 1939 and became an American citizen that year. Through his work on automatic feedback-control systems and numerically-controlled machine tools, Dr. Brown helped transform modern industrial practice. His curricular innovations placed a strong emphasis on fundamental science disciplines such as physics and mathematics and continue to shape engineering curricula at MIT and elsewhere. Even after his retirement, he maintained a lively interest in education, helping to improve the teaching curriculum and computer resources for his local public school system.

Evsey D. Domar, Ford International Professor of Politics Emeritus, died on April 1, 1997 in Concord, Massachusetts. Dr. Domar was 82 years old and had been retired from MIT since 1984. Born in Poland and raised in Manchuria, he emigrated to the U.S. in 1936 at the age of 22. He held a BA from UCLA, MS degrees in mathematics from both the University of Michigan and Harvard, and a Harvard PhD in Economics. A full professor of economics at MIT from 1957 to 1984, he was an internationally recognized exponent of Keynesian theory and an expert in the economics of the Soviet Union during the Cold War era.

Albert G. Hill, Professor Emeritus of Physics, died in Needham, Massachusetts, on October 21, 1996 at the age of 86. A central figure in the development of radar, he helped lead the creation of the air defense and radar-based early-warning systems deployed by the U.S. military in the 1950s and 1960s. His long and remarkably diverse MIT career included service successively as Director of the Research Laboratory of Electronics, Director of Lincoln Laboratory, Deputy Head of the Physics Department, Vice President for Research, and Director of the Plasma Fusion Center. Dr. Hill also presided over the 1973 transformation of the MIT Instrumentation Laboratory into the independent Charles Stark Draper Laboratory, serving as the Chairman of the Draper board until 1982. Dr Hill was an early and effective advocate for equal opportunity and affirmative action programs at MIT, within his own department and for the Institute as a whole.

Professor Emeritus Irving Kaplan, a founding member of the Department of Nuclear Engineering, died at the age of 84 on April 10, 1997, at Massachusetts General Hospital. A member of the original Manhattan Project team, he was a founding member of the Federation of American Scientists, a group which was active in advocating the creation a civilian Atomic Energy Commission as an alternative to military control of nuclear energy. He had retired from MIT in 1978 but continued to teach as a senior lecturer until 1989. In addition to nuclear engineering, he developed and taught humanities subjects in fields including the history of science and Classical Greek.

Thomas H. D. Mahoney, Professor of History Emeritus and an expert on Edmund Burke, died in Palo Alto, California, on April 23, 1997. During his three decades on the faculty, he also held elective office in Cambridge and as a member of the Massachusetts House of Representatives from 1971 to 1978. He served from 1979 to 1982 as the Massachusetts Secretary of Elder Affairs. In his mid-seventies, he earned MA and PhD degrees in public administration and began consulting on issues of aging and urbanization, while maintaining an interest in Asian affairs. His death at the age of 83 came while he was returning from Seoul, Korea, where he had addressed the 97th Interparliamentary Union Conference.

James E. McCune died on December 13, 1996, in Wakefield, Massachusetts. Dr. McCune had retired earlier in the year as a Professor of Aeronautics and Astronautics. A popular and enthusiastic teacher who won numerous teaching awards, Dr. McCune came to MIT as an associate professor in 1963 and was promoted to full professor in 1968. His

skill in the design and study of jet turbine engines resulted in a Lawrence Sperry Award from the American Institute of Aeronautics and Astronautics and his appointment as Director of MIT's Gas Turbine Laboratory in 1978-79. He was 65 years old.

J. Edward Vivian, Professor Emeritus of Chemical Engineering, died at the age of 83 on July 23, 1996, in Burlington, Vermont. A native of Montreal who had trained in his youth as a concert pianist, Dr. Vivian became interested in chemistry as a student at McGill University. He came to MIT in 1937, earning an SM and ScD in 1939 and 1945 and was a member of the faculty until his retirement in 1980. During World War II, he, like his faculty colleague Albert Hill, worked for the Department of Defense on the Manhattan Project. Throughout his academic career, he took a major interest in his department's Practice School program, which brings students, teachers, and industry professionals together to solve practical problems for the chemical engineering industry.

STATISTICS FOR THE YEAR

REGISTRATION

In 1996-97 student enrollment was 9,947, compared with 9,960 in 1995-96. There were 4,429 undergraduates (4,495 the previous year) and 5,518 graduate students (5,465 the previous year). The international student population was 2,144, representing 8 percent of the undergraduate and 33 percent of the graduate populations. These students were citizens of 104 countries. (Students with permanent residence status are included with U.S. citizens.)

In 1996-97, there were 3,085 women students (1,749 undergraduate and 1,336 graduate) at the Institute, compared with 3,013 (1,705 undergraduate and 1,308 graduate) in 1995-96. In September 1996, 451 first-year women entered MIT, representing 42 percent of the freshman class of 1,074 students.

In 1996-97, there were, as self-reported by students, 2,753 minority students (1,997 undergraduate and 756 graduate) at the Institute, compared with 2,630 (1,980 undergraduate and 650 graduate) in 1995-96. Minority students included 422 African Americans (non-Hispanic), 41 Native Americans, 564 Hispanic Americans, and 1,726 Asian Americans. The first-year class entering in September 1996 included 509 minority students, representing 47 percent of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 1996-97 included 1,165 bachelor's degrees, 1,414 master's degrees, 16 engineer's degrees, and 514 doctoral degrees – a total of 3,109 (compared with 3,155 in 1995-96).

STUDENT FINANCIAL AID

During the academic year 1996-97 the continuing healthy economy and a reduction in the number of needy students reduced the need for grant funds. At the same time, endowment income for scholarships increased by 11 percent. A total of 2,609 students who demonstrated need for assistance (59 percent of enrollment) received \$34,110,000 in grant aid and \$15,864,000 in student loans from all sources. The total, \$49,974,000, is approximately the same as last year.

Grant assistance to undergraduates was provided by \$13,269,000 in income from the scholarship endowment, by \$986,000 in current gifts, by \$3,787,000 in federal grants (including ROTC scholarships), and by \$3,160,000 in direct grants from non-federal outside sources to needy students. In addition, \$12,908,000 in scholarships from MIT's unrestricted funds was provided to undergraduates, inclusive of the special program of scholarship aid to needy minority group students that represented \$341,000, and the MIT Opportunity Awards that accounted for \$491,000. An additional 564 students received grants irrespective of need from outside agencies, totaling \$3,555,000. The undergraduate scholarship endowment was increased by the addition of \$10,354,000 in new funds. These new contributions increased the endowment for scholarships to \$130,730,000.

Loans totaling \$15,864,000 were made to undergraduates, an increase of 1 percent from last year. Of the total loans made, \$2,118,000 came from the Technology Loan Fund, \$4,315,000 came from the Federal Perkins Loan Program, and \$9,335,000 came from the federal Direct Loan Program. An additional \$96,000 was provided to undergraduates from other outside sources.

Graduate students obtained \$4,631,000 from the Technology Loan Fund, an increase of 1 percent from last year's level. Graduate students obtained \$9,288,000 from the Federal Stafford Program, \$21,000 in Perkins Loan funds, and \$184,000 from other outside sources. The total, \$14,124,000 is an increase of less than one-half of 1 percent over last year.

The total of loans made to undergraduate and graduate students was \$29,998,000, increasing less than 1 percent over the last year.

The number of needy undergraduate students decreased by 1 percent to 2,609. The average need for this population increased by 3 percent, to \$20,668. In the aggregate, the financial aid program required \$27,212,000 from needy students' family resources and provided \$53,928,000 in aid dollars including work programs. As in past years, the aid program provided more than two-thirds of needy students' total costs.

CAREER SERVICES AND PREPROFESSIONAL ADVISING

In 1996-97, the market for new MIT graduates soared in every area of industry, and a record-breaking number of employers visited the office. The number of individual employers (not including individual divisions of larger corporations) who came to interview was 715 compared to 637 the previous year. As the year came to a close, interview schedules for 1997-98 suggested that the upward trend would continue in the year ahead.

Software skills continued to be the most sought-after single area of student expertise, with particular emphasis on new multimedia and Internet technologies, and employers have learned that students from a wide variety of MIT courses have substantial experience with information technology. The telecommunications, pharmaceutical, finance, and semiconductor industries have contributed noticeably to this demand. Starting salaries have increased, as has the percentage and range of firms offering signing bonuses. Salary ranges for doctoral graduates in engineering are on the average \$68,000-74,000. Master candidates' offers range from \$48,000-54,000 and bachelor candidates' from \$40,000-42,000.

Student interest in medical school has continued to rise. This year, 117 seniors applied to medical school, with 71 percent admitted. The number of alumni/ae applicants has doubled since 1988 and nearly tripled since 1986; this year, 85 MIT alumni applied to medical school. A total of 124 men and 89 women (undergraduates, graduate students, and alumni) applied to medical school, and the acceptance rate was 62 percent in both cases, including re-applicants.

GIFTS

Private support for Fiscal Year 1997 totaled \$133,600,000, including the following: \$126,200,000 in gifts, grants, and bequests, and \$7,400,000 million in support through membership in the Industrial Liaison Program. The total compares with \$130,900,000 in 1996, \$108,900,000 in 1995, \$94,500,000 in 1994, and \$96,800,000 in 1993. Gifts-in-kind for the past year (principally gifts of equipment) were valued at \$11,200,000.

Sources of gifts for Fiscal Year 1997 were: alumni, \$48,900,000; non-alumni friends, \$17,800,000; corporations, corporate foundations, and trade associations, \$30,200,000; foundations and charitable trusts, \$27,700,000; and others, \$1,600,000.

FINANCES

As reported by the Vice President for Finance and Treasurer, the overall financial results of the Institute's operations were favorable during Fiscal Year 1997. Revenues and funds of \$1,181,700,000 was used for operations. Total operating expenses in Fiscal Year 1997 were \$1,186,600,000. The operating results produced an additional need for general funds of \$4,900,000, a decline from the \$8,500,000 deficit in the prior year. In addition, net assets increased \$626,100,000, which included net investment gains of \$564,600,000, and reached almost \$3.9 billion at year end. The MIT endowment reached a market value of \$3.02 billion, up 21.3 percent, and benefited from a strong flow of gifts and from large market gains.

The research revenues of departmental and interdepartmental laboratories, primarily on campus, totaled \$387,900,000 in Fiscal Year 1997, an increase of 2.8 percent. This was the first year that industry replaced a governmental agency as MIT's leading sponsor of research on campus. Lincoln Laboratory reported total revenues of \$352,600,000, an increase of 2.7 percent.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

While many physical changes to the campus were evident once again this year, perhaps the most striking changes involved new ways of doing business and dramatic changes in personnel brought about by the one-time Retirement Incentive Program. In the Operations areas alone, 110 individuals retired, including five long-serving department heads. These changes in personnel necessitated reorganization in some instances and searches for replacements in others.

Steady progress continued on the reengineering front, as many processes were redesigned or restructured. Following a review of the publication, copy, and audio-visual needs of the Institute, the Office of Design Services and the typesetting, offset printing, and photography sections in Graphic Arts ceased operations at the end of August. The

Copy Technology Services and Audio Visual Services became autonomous departments, and a new service, the Publishing Services Bureau, began to coordinate the planning and production of the Institute's print and electronic publications.

SAP became the Institute's financial system of record on September 3, 1996. A major communications effort was launched at that time in order to keep the broader community abreast of the changes and to identify and quickly resolve the operational issues that inevitably accompany such an undertaking.

The Office of Facility Management Systems separated from the Institute in September, and the Institute's space accounting functions were assumed by Physical Plant.

Many physical improvements to the campus were evident as well. Chilled water capacity was greatly expanded at the Central Utilities Plant, and additional cooling tower capacity was expected to go on-line early in the next year. Building 56 was occupied following renovation, and the total renovation of Building 16 commenced late in the winter. The renovation of Senior House set a new standard of accomplishment, with \$11,000,000 of construction completed in just 12 weeks during the summer. Exterior work on the building, including a new main entrance on Amherst Street, was expected to be completed early the next year.

Four Institute projects received awards during the year. The School of Architecture and Planning renewal project, the Tang Center, and the Cogeneration project won design awards from the Boston Society of Architects (BSA), while the BSA and the Associated General Contractors jointly awarded Senior House an Owner Excellence Award. In addition, the U.S. Environmental Protection Agency named Physical Plant its "Partner of the Year" for the Plant's dedication to promoting energy-efficient lighting.

As in past years, we continue to be committed to the safety of all who live and work on the campus. Training and education to ensure compliance with Institute policies and government regulations continue to be a priority. The number of thefts of Institute property and personal property, including thefts from residence halls, all decreased from those recorded last year.

PERSONNEL CHANGES

CORPORATION

CHANGES OF APPOINTMENT

Paul E. Gray
Life Member, Emeritus

George N. Hatsopoulos
Life Member, Emeritus

Christian J. Matthew
Life Member, Emeritus

ELECTIONS

Gregory K. Arenson
Member

Osie V. Combs, Jr.
Member

Norman E. Gaut
Member

Lissa A. Martinez
Member

Duwayne J. Peterson, Jr.
Member

Gerhard H. Schulmeyer
Member

Elisabeth A. Stock
Member

Susan E. Whitehead
Member

Robert E. Wilhelm
Member

MEMBER EX-OFFICIO

Robert M. Metcalfe
President of the Association
of Alumni and Alumnae

TERMS EXPIRED

Pedro Aspe
Member

Gerald J. Burnett
Member

Alan B. Davidson
Member

Sir Robert B. Horton
Member

Nannerl O. Keohane
Member

William B. Lenoir
Member

Robert M. Metcalfe
Member

Romano Prodi
Member

FACULTY

DEATHS

Herbert L. Beckwith
Professor
School of Architecture and
Planning

Gordon S. Brown
Institute Professor
Institute Professors

Evsey D. Domar
Professor
Department of Economics

Rosemary Grimshaw
Assistant Professor
Department of Architecture

Albert G. Hill
Senior Lecturer/ Professor
Emeritus
Department of Physics

Irving Kaplan
Senior Lecturer/ Professor
Emeritus
Department of Nuclear
Engineering

Thomas H. D. Mahoney
Professor
History Section

James E. McCune
Professor
Department of Aeronautics
and Astronautics

J. Edward Vivian
Senior Lecturer/ Professor
Emeritus
Department of Chemical
Engineering

John B. Wilbur
Professor
Department of Civil and
Environmental Engineering

RETIREMENT

Michel Baranger
Professor
Department of Physics

Abraham Bers
Professor
Department of Electrical
Engineering and Computer
Science

Gene M. Brown
Professor
Department of Biology

Bernard F. Burke
Professor
Department of Physics

A. Douglas Carmichael
Professor
Department of Ocean
Engineering

Elzbieta E. Chodakowska
Professor
Program in Writing and
Humanistic Studies

George W. Clark
Professor
Department of Physics

Fernando J. Corbato
Professor
Department of Electrical
Engineering and Computer
Science

Arnold L. Demain
Professor
Department of Biology

John J. Donovan
Adjunct Professor
Sloan School of
Management

Alvin W. Drake
Professor
Department of Electrical
Engineering and Computer
Science

Ira Dyer
Professor
Department of Ocean
Engineering

Maurice S. Fox
Professor
Department of Biology

Lawrence S. Frishkopf
Professor
Department of Electrical
Engineering and Computer
Science

Robert G. Gallager
Professor
Department of Electrical
Engineering and Computer
Science

Carl W. Garland
Professor
Department of Chemistry

Malcolm L. Gester
Professor
Department of Biology

Lynn W. Gelhar
Professor
Department of Civil and
Environmental Engineering

Leonard A. Gould
Professor
Department of Electrical
Engineering and Computer
Science

Peter Griffith
Professor
Department of Mechanical
Engineering

Elias P. Gyftopoulos
Professor
Department of Nuclear
Engineering

Gary A. Hack
Professor
Department of Urban
Studies and Planning

Morris Halle
Institute Professor
Institute Professors

Otto K. Harling
Professor/ Director
Nuclear Reactor Laboratory

Peter Holland
Associate Professor
Athletic Department

Walter M. Hollister
Professor
Department of Aeronautics
and Astronautics

Ali Javan
Professor
Department of Physics

Willard R. Johnson
Professor
Department of Political
Science

Justin E. Kerwin
Professor
Department of Ocean
Engineering

Nelson Y- S Kiang
Professor
Harvard-MIT Division of
Health Sciences and
Technology

Melvin H. King
Adjunct Professor
Department of Urban
Studies and Planning

Charles C. Ladd
Professor
Department of Civil and
Environmental Engineering

Koichi Masubuchi
Professor
Department of Ocean
Engineering

Alan L. McWhorter
Professor
Department of Electrical
Engineering and Computer
Science

Edward W. Merrill
Professor
Department of Chemical
Engineering

Travis R. Merritt
Dean for Undergraduate
Academic Affairs,
Professor of Literature
Office of the Dean of
Students and
Undergraduate Education

Frederic R. Morgenthaler
Professor
Department of Electrical
Engineering and Computer
Science

J. Nicholas Newman
Professor
Department of Ocean
Engineering

T. Francis Ogilvie
Professor
Department of Ocean
Engineering

Louis S. Osborne
Professor
Department of Physics

Sheldon Penman
Professor
Department of Biology

Frank E. Perkins
Professor
Office of the Provost

Carl R. Peterson
Professor
Department of Mechanical
Engineering

Ronald F. Probst
Professor
Department of Mechanical
Engineering

Adel F. Sarofim
Professor
Department of Chemical
Engineering

Thomas B. Sheridan
Professor
Department of Mechanical
Engineering

Ethan R. Signer
Professor
Department of Biology

Eugene B. Skolnikoff
Professor
Department of Political
Science

Irene Tayler
Professor
Literature Section

Richard D. Thornton
Professor
Department of Electrical
Engineering and Computer
Science

John S. Waugh
Institute Professor
Institute Professors

Myron Weiner
Professor
Department of Political
Science

Gerald N. Wogan
Professor/ Director
Division of Toxicology

RESIGNATIONS

Professor

Ehud Hrushovski
Professor
Department of Mathematics

Julio J. Rotemberg
Professor
Sloan School of
Management

Associate Professor

Ezra Getzler
Associate Professor
Department of Mathematics

Kenneth William Haase, Jr.
Associate Professor
Program in Media Arts and
Sciences

Vien Nguyen
Associate Professor
Sloan School of
Management

Thomas Piketty
Associate Professor
Department of Economics

James B. Rebitzer
Associate Professor
Sloan School of
Management

G. Peter Wilson
Associate Professor
Sloan School of
Management

Hans- Conrad Zur Loye
Associate Professor
Department of Chemistry

Andrew B. Bernard
Assistant Professor
Department of Economics

Alberto Bisin
Assistant Professor
Department of Economics

Delia Margaret Boylan
Assistant Professor
Department of Political
Science

Sheldon Chang
Assistant Professor
Department of Mathematics

Kristina E. Hill
Assistant Professor
Department of Urban
Studies and Planning

Xiangdong Ji
Assistant Professor
Department of Physics

Pawan Kumar
Assistant Professor
Department of Physics

Martin D. Roberts
Assistant Professor
Foreign Languages and
Literatures Section

Suzan D. Rowe
Assistant Professor
Athletic Department

PROMOTIONS

to Professor

Abhijit Banerjee
Professor
Department of Economics

Moungi G. Bawendi
Professor
Department of Chemistry

Edmund W. Bertschinger
Professor
Department of Physics

Christopher C. Cummins
Professor
Department of Chemistry

Michael A. Cusumano
Professor
Sloan School of
Management

William J. Dally
Professor
Department of Electrical
Engineering and Computer
Science

John P. Grotzinger
Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Wesley L. Harris
Professor
Department of Aeronautics
and Astronautics

Ian Hunter
Professor
Department of Mechanical
Engineering

Mehran Kardar
Professor
Department of Physics

Leonid Levitov
Professor
Department of Physics

Alec P. Marantz
Professor
Department of Linguistics
and Philosophy

Dennis McLaughlin
Professor
Department of Civil and
Environmental Engineering

William G. Quinn, Jr.
Professor
Department of Brain and
Cognitive Sciences

Daniel H. Rothman
Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Emanuel M. Sachs
Professor
Department of Mechanical
Engineering

Paraskevas Sphicas
Professor
Department of Physics

Hermann Steller
Professor
Department of Brain and
Cognitive Sciences

John L. Tonry
Professor
Department of Physics

To Associate Professor

Anuradha Annaswamy
Associate Professor
Department of Mechanical
Engineering

Stephen Ansolabehere
Associate Professor
Department of Political
Science

Peter Belobaba
Associate Professor
Department of Aeronautics
and Astronautics

Sibel Bozdogan
Associate Professor
Department of Architecture

Kenneth S. Breuer
Associate Professor
Department of Aeronautics
and Astronautics

James Buzard
Associate Professor
Literature Section

David G. Cory
Associate Professor
Department of Nuclear
Engineering

Peter C. Dedon
Associate Professor
Division of Toxicology

David C. Dunand
Associate Professor
Department of Materials
Science and Engineering

Sergey Fomin
Associate Professor
Department of Mathematics

David Genesove
Associate Professor
Department of Economics

Neil A. Gershenfeld
Associate Professor
Program in Media Arts and
Sciences

Michel X. Goemans
Associate Professor
Department of Mathematics

Linda G. Griffith
Associate Professor
Department of Chemical
Engineering

Hugh Gusterson
Associate Professor
Anthropology Program

Simone Hochgreb
Associate Professor
Department of Mechanical
Engineering

M. Frans Kaashoek
Associate Professor
Department of Electrical
Engineering and Computer
Science

Chris Kaiser
Associate Professor
Department of Biology

Michael Kremer
Associate Professor
Department of Economics

Leonid Levitov
Associate Professor
Department of Physics

James D. Paduano
Associate Professor
Department of Aeronautics
and Astronautics

Ann M. Pendleton-Jullian
Associate Professor
Department of Architecture

James Propp
Associate Professor
Department of Mathematics

Lisa J. Randall
Associate Professor
Department of Physics

Mitchel J. Resnick
Associate Professor
Program in Media Arts and
Sciences

Hazel L. Sive
Associate Professor
Department of Biology

Lones A. Smith
Associate Professor
Department of Economics

David L. Trumper
Associate Professor
Department of Mechanical
Engineering

Elizabeth A. Wood
Associate Professor
History Section

Gregory W. Wornell
Associate Professor
Department of Electrical
Engineering and Computer
Science

Jackie Y. Ying
Associate Professor
Department of Chemical
Engineering

J. Nicholas Ziegler
Associate Professor
Sloan School of
Management

**CHANGES OF
APPOINTMENT**

Dimitri A. Antoniadis
Ray and Maria Stata
Professor
Department of Electrical
Engineering and Computer
Science

H. Harry Asada
Ford Professor
Department of Mechanical
Engineering

Paul Asquith
Nanyang Technological
University Professor of
Management
Sloan School of
Management

Moshe E. Ben-Akiva
Edmond K. Turner
Professor
Department of Civil and
Environmental Engineering

Stephen A. Benton
Director and Professor
Center for Advanced Visual
Studies

Bruce M. Blumberg
Asahi Corporation Career
Development Assistant
Professor of Media Arts
and Sciences
Program in Media Arts and
Sciences

Duane S. Boning
Itt Career Development
Assistant Professor
Department of Electrical
Engineering and Computer
Science

John G. Brisson, II
Roger and Gail McCarthy
Career Development
Assistant Professor
Department of Mechanical
Engineering

Rodney A. Brooks
Fujitsu Professor of
Computer
Department of Electrical
Engineering and Computer
Science

Stephen L. Buchwald
Camille Dreyfus Professor
Department of Chemistry

Justine Cassell
At&T Career Development
Assistant Professor
Program in Media Arts
and Sciences

Ismail Chabini
Gilbert T. Winslow Career
Development Assistant
Professor
Department of Civil and
Environmental Engineering

Peter Child
Section Head and Professor
Music and Theater Arts
Section

Edward F. Crawley
Department Head and
Macvicar Fellow Professor
Department of Aeronautics
and Astronautics

Isabelle De Courtivron
Professor
Foreign Languages and
Literatures Section

David C. Dunand
Amax Associate Professor
Department of Materials
Science and Engineering

Alan H. Epstein
Richard Cockburn
McLaurin Professor
Department of Aeronautics
and Astronautics

Michael M. J. Fischer
Department Head and
Professor
Program in Science,
Technology, and Society

Suzanne Flynn
Section Head and Professor
Foreign Languages and
Literatures Section

David G. Forney
Bernard M. Gordon
Adjunct Professor
Department of Electrical
Engineering and Computer
Science

Gregory C. Fu
Firmenich Assistant
Professor
Department of Chemistry

Lorna J. Gibson
Matoula S. Salapatias
Professor
Department of Materials
Science and Engineering

Shafirra Goldwasser
RSA Professor of
Computer Science and
Engineering
Department of Electrical
Engineering and Computer
Science

Linda G. Griffith
Karl Van Tassel Career
Development Professor
Department of Chemical
Engineering

Edward J. Hall
Assistant Professor
Department of Linguistics
and Philosophy

Douglas Hart
D. Fort Flowers Career
Development Assistant
Professor
Department of Mechanical
Engineering

Diana Henderson
Associate Professor
Literature Section

Ian Hunter
Hatsopoulos Professor
Department of Mechanical
Engineering

Mark Jarzombek
Associate Professor
Department of Architecture

Simon Johnson
Visiting Associate
Professor
Sloan School of
Management

Paul R. Krugman
Ford International
Professor
Professor of Economics

Steven B. Leeb
Carl Richard Soderberg
Assistant Professor in
Power Engineering
Department of Electrical
Engineering and Computer
Science

Barbara H. Liskov
Ford Professor of
Engineering
Department of Electrical
Engineering and Computer
Science

Tomas Lozano-Perez
Cecil H. Green Professor of
Computer Science and
Engineering
Department of Electrical
Engineering and Computer
Science

Nancy A. Lynch
Nec Professor of Software
Engineering
Department of Electrical
Engineering and Computer
Science

Pauline Maier
Professor and Acting
Section Head
History Section

Roger G. Mark
Professor
Harvard-MIT Division of
Health Sciences and
Technology

Dennis McLaughlin
H. M. King Bhumipol
Professor
Department of Civil and
Environmental Engineering

Oliver G. McGee
Martin Luther King, Jr.
Visiting Associate
Professor
Department of Civil and
Environmental Engineering

Fred Moavenzadeh
Professor and Director
Technology and
Development Program

Earl M. Murman
Ford Professor of
Engineering
Department of Aeronautics
and Astronautics

Amedeo R. Odoni
T. Wilson Professor
Department of Aeronautics
and Astronautics

Alan V. Oppenheim
Ford Professor of
Engineering and
Distinguished Professor
Department of Electrical
Engineering and Computer
Science

Anthony T. Patera
School of Engineering
Professor of Teaching
Innovation
Department of Mechanical
Engineering

Feniosky Pena-Mora
Gilbert T. Winslow Career
Development Assistant
Professor
Department of Civil and
Environmental Engineering

Paul Alex Pentland
Department Head and
Associate Professor
Program in Media Arts and
Sciences

William W. Quivers
Visiting Professor
Department of Physics

Richard L. Schmalensee
Gordon Y. Billard
Professor
of Management and Deputy
Dean
Sloan School of
Management

Warren P. Seering
Director Center for
Competitive Product
Development and Weber-
Shaughness Professor
Department of Mechanical
Engineering

Sarah Slaughter
Gilbert T. Winslow Career
Development Assistant
Professor
Department of Civil and
Environmental Engineering

Merritt Roe Smith
Professor
Program in Science,
Technology, and Society

Robert Stalnaker
Laurance S. Rockefeller
Professor of Philosophy
Department of Linguistics
and Philosophy

Edward S. Steinfeld
Mitsubishi Career
Development Assistant
Professor
Sloan School of
Management

Hermann Steller
Professor
Department of Biology

John Sterman
Standish Professor of
Management
Sloan School of
Management

Gerald J. Sussman
Matsushita Professor of
Electrical Engineering
Department of Electrical
Engineering and Computer
Science

Joseph M. Sussman
J. R. East Professor
Department of Civil and
Environmental Engineering

Seth Teller
X-Consortium Assistant
Professor of Computer
Science
Department of Electrical
Engineering and Computer
Science

Harry L. Tuller
Sumitomo Electric
Industries Professor of
Ceramic Engineering
Department of Materials
Science and Engineering

Bettina Voelker
Assistant Professor
Department of Civil and
Environmental Engineering

David Wallace
Esther and Harold E.
Edgerton Assistant
Professor
Department of Mechanical
Engineering

Peter G. Wilson
Gordon Y. Billard Career
Development Associate
Professor
Sloan School of
Management

David Woodruff
Assistant Professor
Department of Political
Science

Gregory W. Wornell
Cecil and Ida Green Career
Development Associate
Professor
Department of Electrical
Engineering and Computer
Science

NEW APPOINTMENTS

Professor

Paul R. Krugman
Professor
Department of Economics

Vann McGee
Professor
Department of Linguistics
and Philosophy

Tomasz S. Mrowka
Professor
Department of Mathematics

Elizabeth S. Spelke
Professor
Department of Brain and
Cognitive Sciences

Timothy M. Swager
Professor
Department of Chemistry

Associate Professor

Dennis Adams
Associate Professor
Department of Architecture

Joshua Angrist
Associate Professor
Department of Economics

Sabine Iatridou
Associate Professor
Department of Linguistics
and Philosophy

Assistant Professor

Saman P. Amarasinghe
Assistant Professor
Department of Electrical
Engineering and Computer
Science

David Bartel
Assistant Professor
Department of Biology

Bruce M. Blumberg
Assistant Professor
Program in Media Arts and
Sciences

Carlos E. S. Cesnik
Boeing Career
Development Assistant
Professor
Department of Aeronautics
and Astronautics

John M. Chapin
Assistant Professor
Department of Electrical
Engineering and Computer
Science

Andrew Chess
Assistant Professor
Department of Biology

Kenneth R. Czerwinski
N. C. Rasmussen Career
Development Assistant
Professor
Department of Nuclear
Engineering

Michel A. F. Degraff
Assistant Professor
Department of Linguistics
and Philosophy

Chrysanthos N. Dellarocas
Assistant Professor
Sloan School of
Management

Susan Giaimo
Assistant Professor
Department of Political
Science

Guosong Liu
Assistant Professor of
Neurobiology
Department of Brain and
Cognitive Sciences

Chris H. Luebke
Assistant Professor
Department of Architecture

John Maeda
Assistant Professor
Program in Media Arts and
Sciences

Lakshminarayana
Mahadevan
Assistant Professor
Department of Mechanical
Engineering

James Makubuya
Assistant Professor
Music and Theater Arts
Section

Leonard McMillan
Assistant Professor
Department of Electrical
Engineering and Computer
Science

Alexandre Megretski
Assistant Professor
Department of Electrical
Engineering and Computer
Science

David A. Mindell
Frances and David Dibner
Assistant Professor of the
History of Engineering and
Manufacturing
Program in Science,
Technology, and Society

Rajeev J. Ram
Assistant Professor
Department of Electrical
Engineering and Computer
Science

Nelson Repenning
Assistant Professor
Sloan School of
Management

Caroline A. Ross
Lord Foundation Career
Development Assistant
Professor of Materials
Science
Department of Materials
Science and Engineering

Sylvia L. Sanders
Assistant Professor
Department of Biology

Scott Shane
Leghorn Career
Development Assistant
Professor
Sloan School of
Management

Karen E. Smith
Assistant Professor
Department of Mathematics

Peter T. C. So
Assistant Professor
Department of Mechanical
Engineering

David M. Spector
Assistant Professor
Department of Economics

Daniel A. Spielman
Assistant Professor of
Applied Mathematics
Department of Mathematics

Edward S. Steinfeld
Assistant Professor
Sloan School of
Management

Maurice H. Van Putten
Assistant Professor of
Applied Mathematics
Department of Mathematics

Robin E. Wells
Assistant Professor
Department of Economics

Stuart Gordon White
Assistant Professor
Department of Political
Science

Cheryl Zoll
Assistant Professor
Department of Linguistics
and Philosophy

Adjunct Professor

Olivier D. Faugeras
Adjunct Professor
Department of Electrical
Engineering and Computer
Science

David G. Forney
Adjunct Professor
Department of Electrical
Engineering and Computer
Science

Noel M. McKinnell
Adjunct Professor
Department of Architecture

Visiting Professor

Edith K. E. Ackermann
Visiting Professor
Department of Architecture

Gilda A. Barabino
Visiting Nsf Professor
Department of Chemical
Engineering

Avraham Beja
Visiting Professor
Sloan School of
Management

Andre Clement
Visiting Professor
Department of Ocean
Engineering

James W. Demmel
Visiting Professor
Department of Electrical
Engineering and Computer
Science

Edward A. Dratz
Visiting Professor
Francis Bitter Magnet
Laboratory

Jens Feder
Visiting Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Claude J. Frankignoul
Visiting Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Javier Gonzalez-Garcia
Visiting Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Charles Hadlock
Visiting Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

James T. Higginbotham
Visiting Professor
Department of Linguistics
and Philosophy

Deborah Kolb
Visiting Professor
Sloan School of
Management

Bruce Lehmann
Visiting Professor
Sloan School of
Management

Barbara Lust
Visiting Professor
Foreign Languages and
Literatures Section

Shlomo Maital
Visiting Professor
Sloan School of
Management

Donald S. Matteson
Visiting Professor
Department of Chemistry

James M. McInnes
Visiting Professor
Sloan School of
Management

Rafael Navarro-Gonzalez
Visiting Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Shelby F. Nelson
Visiting Professor
Materials Processing
Center

Suzanne O'Connell
Visiting Professor
Department of Earth,
Atmospheric, and Planetary
Sciences

Costas Papanicolas
Visiting Professor
Department of Physics

Mary B. Parlee
Visiting Professor
School of Humanities and
Social Science

William Reiff
Visiting Professor
Department of Chemistry

Walter E. Rodriguez
Martin Luther King, Jr.
Visiting Professor
Department of Civil and
Environmental Engineering

Robert Richard Rooney
Visiting Professor
Military Science

William D. Rutley
Visiting Professor
Air Force Aerospace
Studies

Johannes Schoonman
Visiting Professor
Department of Materials
Science and Engineering

Edith Sylla
Visiting Professor
Program in Science,
Technology, and Society

Robert A. Taggart, Jr.
Visiting Professor of
Finance
Sloan School of
Management

Earl A. Thornton
Visiting Professor
Department of Aeronautics
and Astronautics

Trevor J. Trust
Visiting Professor
Division of Toxicology

Alex Tzonis
Visiting Professor
Department of Architecture

Josep Valor-Sabatier
Visiting Professor
Sloan School of
Management

Robert Van Pelt
Visiting Professor
Department of Architecture

Gideon Weiss
Visiting Professor of
Management
Sloan School of
Management

Kenneth L. Williamson
Visiting Professor
Department of Chemistry

**Visiting Associate
Professor**

Eduardo Ahedo
Visiting Associate
Professor
Department of Aeronautics
and Astronautics

Ricardo Alarcon
Visiting Associate
Professor
Laboratory for Nuclear
Science

William C. Carter
Visiting Associate
Professor
Department of Materials
Science and Engineering

Joel Cutcher-Gershenfeld
Visiting Associate
Professor
Sloan School of
Management

Solomon Eisenberg
Visiting Associate
Professor
Harvard-MIT Division of
Health Sciences and
Technology

Mica R. Endsley
Visiting Associate
Professor
Department of Aeronautics
and Astronautics

Alan D. Fekete
Visiting Associate
Professor
Department of Electrical
Engineering and Computer
Science

Stephanie Forrest
Visiting Associate
Professor
Department of Electrical
Engineering and Computer
Science

Jonathan Gifford
Visiting Associate
Professor
Department of Civil and
Environmental Engineering

Mohamad L. Hammour
Visiting Associate
Professor
Department of Economics

Donald W. Hearn
Visiting Associate
Professor
Sloan School of
Management

Timothy Luehrman
Visiting Associate
Professor
Sloan School of
Management

Alison McIntyre
Visiting Associate
Professor
Department of Linguistics
and Philosophy

Daniel Richards
Visiting Associate
Professor
Sloan School of
Management

Charles B. Rose
Visiting Associate
Professor
Department of Architecture

Hiroshi Sakuta
Visiting Associate
Professor
Department of Civil and
Environmental Engineering

Vivek Sarkar
Visiting Associate
Professor
Department of Electrical
Engineering and Computer
Science

Peter A. Testa
Visiting Associate
Professor
Department of Architecture

Michael Trick
Visiting Associate
Professor
Sloan School of
Management

George Wodicka
Visiting Associate
Professor
Harvard-MIT Division of
Health Sciences and
Technology

Jeremy M. Wolfe
Visiting Associate
Professor
Department of Brain and
Cognitive Sciences

Katherine A. Yelick
Visiting Associate
Professor
Department of Electrical
Engineering and Computer
Science

**Visiting Assistant
Professor**

David A. Becker
Visiting Assistant Professor
Department of Chemistry

Thomas J. Hudson
Visiting Assistant Professor
Department of Biology

Personnel Changes

Kevin T. Kornegay
Visiting Assistant Professor
Department of Electrical
Engineering and Computer
Science

Matthew Krepps
Visiting Assistant Professor
of Management
Sloan School of
Management

Steven L. Lee
Martin Luther King, Jr.
Visiting Assistant Professor
Department of Mathematics

Susan C. Mantell
Visiting Assistant Professor
Department of Mechanical
Engineering

Gita Martohardjono
Visiting Assistant Professor
Foreign Languages and
Literatures Section

George Plesko
Visiting Assistant Professor
Sloan School of
Management

Panajiotis Sakkalis
Visiting Assistant Professor
Department of Ocean
Engineering

Pri Shah
Visiting Assistant Professor
Sloan School of
Management

Alexander Voronov
Visiting Assistant Professor
Department of Mathematics

ADMINISTRATION

DEATHS

Robert A. Barlow
Construction Administrator
Physical Plant

Marie C. Cedrone
Contract Administrator
Office of Sponsored
Programs

Bessie H. Groggett
Administrative Staff
Registrar's Office

Richard Higham
Senior Personnel Office
Personnel Office

Wade K. Hokoda
Administrative Staff
Department of Architecture

W. Kevin Larkin
Assistant Treasurer and
Assistant Director, Capital
Gifts and Legal Affairs
Treasurer's Office

Richard E. Yaple
Analyst Programmer
Lincoln Fiscal Office

RETIREMENTS

Jiro Adachi
Senior Industrial Liaison
Officer
Industrial Liaison Program

Kathleen A. Arthur
Purchasing Agent
The General Purchasing
Department

Ragnhild M. Bairnsfather
Librarian
Libraries

Charles H. Ball
Senior Assistant Director,
News Office
Public Relations Services

Nancie M. Barber
Project Manager, Alumni
Activities
Alumni Association

Joanne C. Barrett
Financial Officer
Department of Biology

Donald A. Batson
Safety Officer and
Manager, Chemical Waste
Program
Safety Office

John B. Bidwell
Facilities Information
Manager
Office of Facilities
Management Systems

Phyllis L. Block
Graduate Administrator,
Mathematics
Department of Mathematics

David E. Burnett
Accounting Officer
Controller's Accounting
Office

Louise E. Carella
Administrative Assistant
Industrial Liaison Program

Nancy E. Cavanagh
Administrative Officer
Music and Theater Arts
Section

Robert N. Clark
Senior Accounting Officer
Controller's Accounting
Office

William J. Coady
Budget Officer
Office of Budget and
Financial Planning

Theodore F. Coleman
Administrative Assistant,
Physics Stock Room
Department of Physics

Nancy Collins
Personnel Representative
Personnel Office

Donald R. Comeau
Property Officer, Lincoln
Laboratory
Lincoln Fiscal Office

John P. Corcoran
House Manager
Housing

Lillian Cornwall
Shift Supervisor, Building
Services
Physical Plant

Kreon L. Cyros
Director
Office of Facilities
Management Systems

Joseph M. Dhosi
Senior Administrative
Officer
Department of Materials
Science and Engineering

Thomas E. Donnelly
Government Property
Officer
Property Office

Alexander Eccles
Training Supervisor,
Building Operations
Physical Plant

Josephine Eisner
Administrator,
Undergraduate Degree
Audit
Registrar's Office

Paul J. Enis
Senior Property Manager
Lincoln Fiscal Office

James B. Enos, Jr.
Senior Accounting Officer
Controller's
Accounting Office

Patricia E. Gavagan
Administrative Assistant
Department of Materials
Science and Engineering

Charles R. Grader
Program Director and
Associate Director,
Executive Education
Sloan School of
Management

Robert W. Hagerty
Manager, Grounds Services
Physical Plant

Lorraine A. Harding
Housing Loan Officer
Treasurer's Office

Magdalena T. Hu
Senior Research Analyst,
Resource Development
Office of Development
Research and Systems

Francis S. Jannetti
Senior Staff Accountant
Controller's Accounting
Office

| | | | |
|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Michael L. Joroff Director of Research and Special Programs School of Architecture and Planning | George J. Pesaturo, Jr. Manager, Support Services Physical Plant | Donald S. Barnie Data Base Analyst Service Process | Kathleen Cragin Manager, Alumni Recognition Processes and Editor Alumni Association |
| Trond Hans Kaalstad Senior Administrative Officer Department of Civil and Environmental Engineering | Philip L. Philips Senior Accounting Officer Lincoln Fiscal Office | Linda O. Becker Supervisor, Technical Processing Services Libraries | Eleanor P. Crawford Staff Associate, Student Activities Finances Office of the Dean of Students and Undergraduate Education |
| Patricia A. Kane Financial Officer Alumni Association | Vernon A. Raine Director Graphic Arts | Michael C. Behnke Dean of Admissions Office of the Dean of Students and Undergraduate Education | Nathaniel L. Crosswhite Applications Development Programmer Office of Facilities Management Systems |
| Philip J. Keohan Controller Vice President for Finance and Treasurer | Raymond E. Roberts Sergeant Campus Police | Sharon L. Belville Technical Writer Support Process | Roy A. Davey Assistant Director, Consortium Management Office of Facilities Management Systems |
| Luise Keohane House Manager Housing | Carole Schildhauer Librarian Libraries | Joost Bosen Major Gifts Officer Office of Individual Giving | Angel De La Cruz Systems Programmer Office of Facilities Management Systems |
| Cornelius F. Kiely Senior Staff Accountant MIT Press | Jacqueline A. Sciacca Administrator for Fellowship Programs Graduate Education Office | Joseph C. Brady Benefits Counselor Personnel Office | Diane M. Delgado Systems Programmer Delivery Process |
| Richard P. Kohut Manager, Audio Visual Graphic Arts | John C. Sears Associate Controller Controller's Accounting Office | Matthew H. Braun Systems Programmer Service Process | Diane M. Devlin Director, Office Computing Vice President for Information Systems |
| Ann M. (Nancy) Langton Senior Accounting Officer Controller's Accounting Office | John J. Shea, Jr. Supervisor/Coach, Mail Services Physical Plant | Scott R. Britton Supervisor, Circulation Services Libraries | Anthony P. Dipesa, Jr. Technical Supervisor Office of Facilities Management Systems |
| Barbara J. Linden Assistant to the Director for Facilities Museum | Maria Clara Valenzuela Conference Coordinator Industrial Liaison Program | Maria S. Byerly Associate Liaison Officer Industrial Liaison Program | Jennifer Dowling Dougherty Special Assistant to the Senior Vice President Office of the Senior Vice President |
| Rodolfo M. Magararu Production Coordinator Service Process | Bruce D. Wedlock Director Lowell Institute | Robert P. Casey Accounting Officer Reengineering- Management Reporting | M. Juliet Drennan Senior Research Analyst, Resource Development Corporate Development |
| John T. McNeill Associate Director for Food Services Housing | David S. Wiley Registrar Vice President for Administration | Raymond A. Charbonneau Systems Coordinator Libraries | Chad J. Dupuis Consultant Support Process |
| Maria S. Muollo-Cabral Assistant Director Office of the Summer Session | RESGINATIONS | William H. Chen Data Base Analyst Service Process | Selwyn M. Eccles Senior Staff Accountant Controller's Accounting Office |
| William Najjar Senior Subcontract Administrator Central Subcontracting Office | Peter Adgate Financial Analyst Sloan School of Management | Adriana Christopher Analyst Programmer Service Process | Ida G. Faber Staff Assistant Office of the Dean of Students and Undergraduate Education |
| Richard E. Newcomb Purchasing Agent Purchasing Field Office | Maryam Afshar Administrative Assistant Academic Computing Services | Cynthia L. Cipriano Staff Administrator, Purchasing and Stores the General Purchasing Department | Stephen A. Fairfield Assistant Director for Operations Leaders for Manufacturing Program |
| John D. O'Sullivan Assistant Controller Controller's Accounting Office | David A. Alexander Facilities Coordinator Physical Plant | Robert W. Coate Facilities Officer Whitaker College of Health Sciences Andtechnology | Herbert P. Fajors Auditor Audit Division |
| Firooz Partovi Senior Consultant Sloan School of Management | Mark A. Angel Auditor Audit Division | Sarah E. Conroy Benefits Analyst Personnel Office | |
| John S. Peck Purchasing Agent the General Purchasing Department | Elizabeth D. Ankers Analyst Programmer Controller's Accounting Office | Lori A. Correale Associate Director of Resource Development Sloan School of Management | |
| | Alemayehu Awoke Auditor Audit Division | Ellen M. Corwin Systems Analyst Sloan School of Management | |
| | Paula Ayers Administrative Officer Athletic Department | | |

Jolanda Farah
Assistant Bursar, Loan
Programs
Office of the Bursar

David S. Ferriero
Associate Director for
Public Services
Libraries

Sharalee M. Field
Assistant Planning Officer
Planning Office

Lynn M. Flury
Assistant to the Bursar,
Loan Collections
Office of the Bursar

Susan A. Funke
Manager, Corporate
Resource Center, Career
Development Office
Sloan School of
Management

Brenda J. Furbush
Administrative Assistant
Industrial Liaison Program

Margaret Gonzalez
Manager of Corporate
Relations
Industrial Liaison Program

Zaragoza A. Guerra, Iii
Assistant Director of
Admissions
Admissions Office

Marc D. Gunderson
Systems Analyst
Office of Development
Research and Systems

Kathleen F. Hagan
Director, MIT Enterprise
Forum
Alumni Association

Ann L. Harlow
Librarian
Libraries

Michael G. Healy
Senior Research Analyst,
Resource Development
Corporate Development

Jafar Hosseinzadeh
Consultant
MIT Computer Connection

Imee M. Jackson
Industrial Liaison Officer
Industrial Liaison Program

Christina H. Jansen
Technology Licensing
Officer
Technology Licensing
Office

Richard R. Janus, Jr.
Senior Staff Accountant
Controller's Accounting
Office

Cynthia W. Kam
Manager of Compensation
Personnel Office

Donna M. Kendall
Associate Director
Student Financial Aid
Office

Nancy E. Killian
Financial Analyst - Re-
Engineering
Vice President for
Information Systems

Elizabeth A. Kowal
Assistant to the Dean, Uaa
Office of the Dean of
Students and
Undergraduate Education

Geraldine Krug
Assistant to the Bursar,
Loan Collections
Office of the Bursar

Alexander Laats
Technology Licensing
Officer
Technology Licensing
Office

Carmen F. Lahan
Accounting Officer
Treasurer's Office

David R. Lampe
Director of
Communications
Sloan School of
Management

Thomas J. Lane, Jr.
Consultant
Support Process

Diana F. Lelacheur
Advisor to International
Scholars
Office of the Provost

Lu Lin
Analyst Programmer
Office of Facilities
Management Systems

Kee Pak Luk
Analyst Programmer
Integration Process

Linda A. Martinez
Librarian
Libraries

Ross Matthews
Associate Director,
Counseling and
Preprofessional Advising
Career Services and
Preprofessional Advising

Merritt Stevens Maxim
Assistant Director, School
Development Services
Office of School
Development Services

William A. Mayer
Librarian
Libraries

Virginia M. McCluskey
Subcontract Administrator
Central Subcontracting
Office

Brian Melanson
Systems Programmer
Service Process

Veronica Mendoza
Admissions Counselor
Admissions Office

Paul A. Michelman
Director of Publications
Sloan School of
Management

Betsy Millard
Senior Major Gifts Officer
Office of Individual Giving

Constance Mitchell
Assistant Intellectual
Property Counsel
Vice President for
Information Systems

Ruben Morfin-Ramirez
Assistant Director, Office
of Minority Education
Office of the Dean of
Students and
Undergraduate Education

Gail Garfield Neuman
Consultant
Support Process

Mary M. L Ni
Assistant Dean, Rca
Office of the Dean of
Students and
Undergraduate Education

Thomas J. Owens
Head, Library Systems
Office
Libraries

Linda A. Petralia
House Manager
Housing

William J. Pierce
Supervisor, Preventive
Maintenance
Physical Plant

Katherine A. Pittsley
Associate Head Librarian
Libraries

Diane C. Proctor
Consultant
Admissions Office

Tracy F. Purinton
Coordinator, Public Service
Center
Office of the Dean of
Students and
Undergraduate Education

Karl C. Ramm
Systems Programmer
The Network Business

Julie M. Raque
Legislative Assistant
Office of the President

William W. Redway, Jr.
Program Director, Alumni
Activities
Alumni Association

Ann Braden Reilly
Senior Analyst Programmer
Student Information
Systems

Barry C. Roberts
General Manager, Office of
Laboratory Supplies
Reengineering-
Management Reporting

Nanette Robicheau
Assistant Planning Officer
Planning Office

Susan J. Rothfuss
Administrative Officer,
Harvard/ MIT Division of
Health Sciences and
Technology
Office of the Provost

Kathleen M. Rowe
Staff Writer/ Editor
Public Relations Services

Heather S. Ryan
Manager for Finance, MIT
Health Plans
Medical Department

Scott G. Sahagian
Financial Administrator
Harvard-MIT Division of
Health Sciences and
Technology

Alison L. Salisbury
Administrative Officer
Department of Political
Science

Audrey H. Saracco
Coordinator, Reunions and
Special Events
Alumni Association

Sarah S. Sarvis
Admissions Counselor
Admissions Office

Nancy J. Schondorf
Licensing Associate
Technology Licensing
Office

Brandi M. Sikorski
Alumni Affairs Officer
Alumni Association

Carter Macready Snowden
Systems Training and
Documentation Specialist
Libraries

Ravi Sompalli
Analyst Programmer
Office of Facilities
Management Systems

Terry L. Spurling
Consultant
MIT Computer Connection

Robert D. St. Cyr
Senior Industrial Liaison
Officer
Industrial Liaison Program

Scott V. Street
Senior Project Manager
Sloan School of
Management

Ronald P. Suduiko
Assistant to the President
for Government and
Community Relations
Office of the President

Sean Sullivan
Assistant Manager, Animal
Resource Program
Division of Comparative
Medicine

Madeline Sunley
Associate Acquisition
Editor
MIT Press

V. Meredith Thomas
Senior Major Gifts Officer
Office of Individual Giving

Kathleen A. Thurston-
Lighty
Assistant Director for
Marketing
Museum

Heather A. Trickett
Assistant to the Dean,
Counseling and Support
Services
Office of the Dean of
Students and
Undergraduate Education

Kimberly A. Trudel
Assistant Manager,
Computer Operations
Vice President for
Information Systems

Deborah K. Tyrrell
Personnel Officer
Personnel Office

David L. Verrill
Associate Director
Corporate Development

Mark D. Virtue
Systems Programmer
Delivery Process

Jeanne L. Washington
Administrator for Graduate
Student Affairs
Department of Political
Science

B. Jean Weidemier
Counsel and Technology
Licensing Officer
Technology Licensing
Office

Gary A. Weston
Consultant
MIT Computer Connection

Carl P. Whitaker
Accounting Officer
Controller's
Accounting Office

Phillip G. Wickens
Manager, Dietary Service
Medical Department

Christine M. Wigton
Graduate Student
Administrator
Department of Economics

Glenn A. Wilder
Supervisor, Mechanical
Services
Physical Plant

Virginia G. Williams
Assistant Manager,
Customer Communications
and Marketing
MIT Computer Connection

Lisa Wright
Network Administrator and
Coordinator
Student Financial Aid
Office

Heahyun Yoo
Librarian
Libraries

Janice Zazinski
Communications Manager
Sloan School of
Management

Eugene Zhrebilov
Data Administrator
Integration Process

NEW APPOINTMENTS

Christine S. Abbott
Assistant to the Bursar,
Loan Collections
Office of the Bursar

Mary Amato-Bacci
Buyer
The General Purchasing
Department

Hans G. Antonsson
Senior Architect/Project
Manager
Physical Plant

Robin W. Arena
Coach, Repair and
Maintenance
Physical Plant

Catherine R. Avril
Assistant Director of
Development
School of Engineering

Sandra Aylor
Associate Liaison Officer
Industrial Liaison Program

Jadranka Badurina-Kucan
Health Education Program
Assistant
Medical Department

Alberto Balestrieri
Assistant to the Director,
Aga Khan Program
Department of Architecture

Sarah Bancroft
Associate Director
Corporate Development

Anna F. Barkley
Project Coordinator, Sloan
Technology Services
Sloan School of
Management

Michael Barrow
Network Engineer
Service Process

Robert A. Basch
Senior Systems
Programmer
Delivery Process

Cathryn J. Baty
Coordinator, International
Students Office
Graduate Education Office

Michael Bergren
Staff Associate, UAA
Office of the Dean of
Students and
Undergraduate Education

Joseph H. Berlinguet
Supervisor/ Coach,
Building Services
Physical Plant

Timothy E. Blackburn
Graphic Designer
Public Relations Services

Andrew Bonvic
Facilities Analyst
Service Process

David G. Booth
Cad Specialist
Physical Plant

Michael Bowers
Auditor
Audit Division

Sharon A. Bradshaw
Staff Accountant
Controller's
Accounting Office

Elizabeth Brinkerhoff
Broker-Print/Design
Specialist
Public Relations Services

Stephen F. Brown
Technology Licensing
Officer
Technology Licensing
Office

Kenneth L. Bruggeman
Institute Copier Program
Manager
Copy Technology Centers

Margaret Bruzelius
Director, Alumni Network
Services
Alumni Association

Christina M. Buffa
Business System Analyst
Reengineering-
Management Reporting

Shawn Bunn
Staff Administrator
Technology Licensing
Office

Christine M. Butts
House Manager
Housing

Richard F. Cahaly, Jr.
Licensing Associate
Technology Licensing
Office

William D. Cain
Personnel Officer
Personnel Office

Deborah M. Cantor-Adams
Assistant Editor
MIT Press

Ronald J. Catella
Project Manager
Physical Plant

Alice Cavallo
Analyst Programmer
Student Financial Aid
Office

Thomas P. Champion
Senior Writer
Office of the President

Ravinder S. Chana
Auditor
Audit Division

Melissa A. Chapman
Alumni Affairs Officer
Alumni Association

Jo-Anne M. Chute
Property Auditor
Property Office

Robert P. Ciavola
Assistant Intellectual
Property Counsel
Office of Sponsored
Programs

Elizabeth I. Cogliano
Coordinator, Student
Programs
Office of the Dean of
Students and
Undergraduate Education

Lisa D. Cohen
Senior Research Analyst,
Resource Development
Office of Development
Research and Systems

Hope M. Colen
Research Analyst
Office of School
Development Services

Jean Margaret Connolly
Records Maintenance
Manager
Alumni Association

Peter L. Cooper
Assistant Director of
Utilities
Physical Plant

Lori A. Correale
Associate Director
of Resource Development
Sloan School of
Management

Jennifer J. Crockett
Administrative Assistant
Academic Computing
Services

Roberta C. Crumrine
Senior Analyst Programmer
Student Information
Systems

Joan M. Cyr
Consultant
Service Process

Melissa A. Damon
Team Leader/Member
Vice President for Human
Resources-Reengineering

Kacey B. Davenport
Admissions Counselor
Admissions Office

Erinellene Dayl
Special Assistant to the
Dean for Undergraduate
Education and Student
Affairs
Undergraduate Education
and Student Affairs
Operations and
Administration

Miriam R. Diamond
Academic Administrator
Department of Chemistry

Karen P. Donahue
Staff Accountant
Controller's Accounting
Office

Robin B. Dotzenrod
Administrative Assistant
Support Process

Eve Louise Downing
Staff Writer/ Editor
Communications and
Donor Relations

Edmund M. Dunn
Director, MIT Enterprise
Forum
Alumni Association

Paul K. Dzus
Journals Subsidiary Rights
Manager
MIT Press

Charles F. Eaton
Assistant Director
Office of School
Development Services

Gerald J. Elias, Jr.
Facilities Analyst
Service Process

Brian D. Ellis
Assistant Broker,
Publishing Services Bureau
Public Relations Services

Alexandra Ellwood
Analyst Programmer
Service Process

Gillian C. Emmons
Assistant to the Vice
President for Finance and
Treasurer
Reengineering-
Management Reporting

Virginia Esau
Administrative Officer
Department of Physics

Stefano Falconi
Director of Budget and
Financial Planning
Vice President for Finance
and Treasurer

Robert V. Ferrara
Director, I / T Delivery
Vice President for
Information Systems

Michael R. Fitzgerald
General Manager, Endicott
House
Endicott House

Patrick William Fitzgerald
Director, Office of Cost
Analysis
Office of Sponsored
Programs

Jean L. Foster
Consultant
Support Process

Beatrice A. Frain
Assistant Planning Officer
Planning Office

Dennis W. Franczak
Financial Analyst
Sloan School of
Management

Stephen Franks
Consultant
MIT Computer Connection

Anna Frazer
Staff Associate, Office of
the President
Office of the President

Paul F. Gallagher
Associate Director of
Partner Relations
Leaders for Manufacturing
Program

H. Lauren Gallant
Administrative Officer
Department of Aeronautics
and Astronautics

Heidi E. Ganss
Alumni Affairs Officer
Alumni Association

Mark Garchinsky
Facilities Analyst
Service Process

Mary Ellen Gearin
Financial Officer
Alumni Association

Mircea D. Gheorghiu
Director of the
Undergraduate Laboratory
Department of Chemistry

Nancy M. Gift
Consultant
Reengineering-
Management Reporting

Barbara Yem-Hang
Gilligan
Financial Manager
Leaders for Manufacturing
Program

Brenda Gillingham
Senior Project Manager
Delivery Process

Irina Gorovits
Analyst Programmer
Student Information
Systems

Steven T. Gottlieb
Research Analyst
Corporate Development

Winfield D. C. Greene
Area Supervisor, Animal
Resources
Division of Comparative
Medicine

Melanie J. Gregerman
System Manager
Department of Economics

Marc D. Gunderson
Systems Analyst
Office of Development
Research and Systems

Carolyn Hanna
Legislative Assistant
Office of the President

Heather A. Harrison
Technical Writer
Support Process

Roya Hasheminejad-Kiley
Senior Database Analyst
Service Process

Philip J. Hatchouel
House Manager
Housing

Jennifer R. Havlicek
Admissions Counselor
Admissions Office

Patricia Healey
Manager, Corporate
Resource Center, Career
Development Office
Sloan School of
Management

Deborah L. Helman
Librarian
Libraries

Bronwen J. Heuer
Consultant
Support Process

Nancy A. Heywood
Archival / Manuscript
Specialist
Libraries

Leslie E. Hopper
Assistant Manager, Animal
Resource Program
Division of Comparative
Medicine

Lisa R. Horowitz
Librarian
Libraries

Ivana Hrga-Griggs
Assistant Advisor to
International Scholars
Office of the Provost

Lindley C. Huey
Research Analyst
Corporate Development

Anthony James Ives
Team Leader/Member
Undergraduate Education
Student Affairs Operations
and Administration

Jonathan A. Ives
Analyst Programmer
Integration Process

Michelle Jackson
Auditor
Audit Division

Kristen D. Jenkins
Assistant Accounting
Officer
Controller's Accounting
Office

Dennis S. Jillson
Accounting Officer
Treasurer's Office

Wei Jin
Budget Officer
Office of Budget
and Financial Planning

Stephen D. Joiner
Sergeant
Campus Police

Ann Rae Jonas
Catalog Manager
MIT Press

Wayne W. Jones
Associate Head Librarian
Libraries

Martine L. Kaiser
Licensing Associate
Technology Licensing
Office

Kevin Kelleher
Analyst Programmer
Student Information
Systems

Cheryl A. Kennedy
Administrative Assistant
Industrial Liaison Program

Philip J. Keohan
Comptroller Emeritus
Vice President for Finance
and Treasurer

Kathryn T. Kibbee
Consultant
Vice President for
Information Systems

Michael C. Killeen
Supervisor/Coach, Mail
Services
Physical Plant

Kris D. Kipp
Marketing Manager
Center for Advanced
Educational Services

| | | | |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ruth Kirchwey Administrative Assistant to Deputy Treasurer Treasurer's Office | Awinash Manmade Safety Officer and Manager, Chemical Waste Program Safety Office | Heather E. O'Brien Assistant to the Bursar, Loan Collections Office of the Bursar | Karin K. Rivard Counsel and Technology Licensing Officer Technology Licensing Office |
| Susan G. Kleinmann Associate Editor and Visiting Professor Department of Physics | Jennifer L. Marshall Associate Planning Officer Planning Office | Patrick J. O'Toole Construction Coordinator Physical Plant | James Rose Industrial Liaison Officer Industrial Liaison Program |
| Anthony J. Knopp Industrial Liaison Officer Industrial Liaison Program | Daniel Martin Assistant Department Head for Facilities and Operations Athletic Department | Rachel Oberai-Soltz Manager of Corporate Relations Corporate Development | David M. Rosenberg Senior Project Manager Reengineering- Management Reporting |
| David W. Kurtz Facilities Analyst Whitaker College of Health Sciences and Technology | Scott McGuire Analyst Programmer Service Process | Linda E. Okun Graduate Administrator Department of Mathematics | Michaela Rudis Coordinator, Educational Services Sloan School of Management |
| Philip C. K. Kwok Special Advisor-China Management Education Programs Sloan School of Management | Heather B. McMullen Librarian Libraries | Carol Orme-Johnson Assistant Dean, Rca Office of the Dean of Students and Undergraduate Education | Michael P. Rutter Assistant Editor MIT Press |
| Carol A. Lademan Project Manager, MIT Enterprise Forum, Inc. Alumni Association | David R. McNeil Analyst Programmer Registrar's Office | Kenneth E. Overton Internet Projects Coordinator MIT Press | Robert J. Sales Associate Director, News Office Public Relations Services |
| Mark C. Lamphier Export Sales Representative MIT Press | Theodore McCabe, Jr. Systems Programmer The Network Business | Paul S. Page Assistant Director for Purchasing and Stores Automated Systems Delivery Process | Robbie A. Savino Analyst Programmer Lincoln Fiscal Office |
| Brian R. Leslie Associate Intellectual Property Counsel Vice President for Information Systems | Aaron P. McKinnon Analyst Programmer Physical Plant | Benjamin Palleiko Technology Licensing Officer Technology Licensing Office | Mary B. Schaefer Director of Communications, Sloan School Sloan School of Management |
| Deborah A. Levinson Consultant Support Process | Margaret Cain McNally Project Manager School of Architecture and Planning | Jennifer H. Pearce Associate Director, Annual Fund, Sloan/Coordinator of Development Data Sloan School of Management | Denise K. Scott Administrator, Astrophysical Journal Editorial Office Department of Physics |
| Peter A. Lewis Associate Director of Real Estate Treasurer's Office | Robert O. Mehrez Financial Analyst Sloan School of Management | Michael Picardo Supervisor/ Coach, Building Services Physical Plant | Linda B. Scott Financial Analyst Sloan School of Management |
| Ling Li Financial Analyst Sloan School of Management | Angela Kay Meyer Alumni Affairs Officer Alumni Association | Kelly Powell Broker-Print/Design Specialist Public Relations Services | Scott D. Sewell Academic Administrator Department of Earth, Atmospheric, and Planetary Sciences |
| Poping Lin Librarian Libraries | Katherine J. Miller Broker-Electronic Publishing Public Relations Services | Jill Pullen Alumni Affairs Officer Alumni Association | Lianne P. Shields Personnel Officer Personnel Office |
| Alison L. Lu Staff Accountant Controller's Accounting Office | June R. Milligan Marketing Development Manager Copy Technology Centers | Neeta Purohit Assistant to the Bursar, Loan Collections Office of the Bursar | Michelle M. Shippie Administrative Assistant Administrative Services: Department of Chemical Engineering and Department Materials Science and Engineering |
| John H. Lyons Administrative Officer Music and Theater Arts Section | James L. Morgan Controller Vice President for Finance and Treasurer | Karl C. Ramm Systems Programmer Service Process | David J. Silverman Staff Architect / Designer Physical Plant |
| Toan T. Mac Benefits Systems Coordinator Personnel Office | Peter J. Narbonne Team Leader/Member Vice President for Human Resources-Reengineering | Greg J. Raposa Construction Coordinator Physical Plant | Jeffrey H. Simpson Director Instrumentation Laboratory Department of Chemistry |
| Kathleen C. Macneil Associate Director Center for Real Estate | Madeleine M. Needles Librarian Haystack Observatory | Thomas A. Reynolds Coach, Repair and Maintenance Physical Plant | Etaine N. Smith Area Administrator Sloan School of Management |
| | Wendy C. Neubert Contract Administrator Office of Sponsored Programs | Jennifer L. Riddell Curatorial Assistant List Visual Arts Center | |
| | Mary E. Nicholson Senior Staff Accountant MIT Press | | |

Cynthia D. Smothers
Librarian
Libraries

Margaret Therese Smyth
Electronic Productions
Editor
MIT Press

Geri-Lyn Sprague
House Manager
Housing

Jennifer Stephens
Advisor to International
Scholars
Office of the Provost

Richard M. Sullivan
Sergeant
Campus Police

Katherine Swan
Graduate Student
Administrator
Department of Economics

Christine Tempesta
Alumni Affairs Officer
Alumni Association

Santina M. Tonelli
Administrator for Graduate
Student Affairs
Department of Political
Science

Virginia D. Tulloch
Senior Analyst Programmer
Student Information
Systems

Angela Suh Um
Alumni Affairs Officer
Alumni Association

Timothy J. Vacha
Staff Accountant
Controller's Accounting
Office

Colleen A. Valente
Associate Head Librarian
Libraries

William C. Van Schalkwyk
Safety Officer
Safety Office

William Velez
Systems Coordinator
Libraries

Joseph P. Vella, Jr.
Coach, Repair and
Maintenance
Physical Plant

Jonathan Jacob Venezian
Analyst Programmer
The Network Business

Angelo Vitiello
Applications Development
Programmer
Department of Electrical
Engineering and Computer
Science

Matthew Wall
Applications Development
Programmer
Department of Mechanical
Engineering

Johannes G. Wanschers
Office Administrator
Libraries

Stephen K. Wetzel
Manager of Engineering
Facilities
Department of Chemical
Engineering

Jane F. White
Consultant
Reengineering-
Management Reporting

Daniel N. Winship
Systems Programmer
Delivery Process

Helen R. Wittek
Investment Associate
Treasurer's Office

Maureen C. Wolfe
Personnel Officer
Vice President for Human
Resources-Reengineering

David J. Woodward
Budget Officer
Office of Budget
and Financial Planning

Sarah H. Wright
Staff Writer/ Editor
Public Relations Services

Mary J. Ziegler
Consultant
Support Process

**CHANGES OF
APPOINTMENT**

John J. Ahern
House Manager
Housing

Bruce N. Anderson
Director, Industrial Liaison
Program
Industrial Liaison Program

Richard P. Anthony
Staff Writer/ Editor
Communications and
Donor Relations

Carlos A. Arcos
Senior Industrial Liaison
Officer
Corporate Development

Emily W. Barrett
Senior Associate Director,
Sloan Development Office
Sloan School of
Management

Kathryn Battillo
Principal Gifts Officer
Resource Development
Vice President

Phillip M. Bernard
Program Director,
Residential Life
Office of the Dean of
Students and
Undergraduate Education

Bruce M. Bernstein
Director, Publishing
Services Bureau
Public Relations Services

Glenn Billingsley
Senior Major Gifts Officer
Office of Individual Giving

Patricia Brady
Team Leader/Member
Vice President for Human
Resources-Reengineering

Maria Brennan
Staff Assistant,
International Student
Advisor
Graduate Education Office

David J. Brittan
Director of Publications
Sloan School of
Management

Stephanie Bromander
Supervisor, Purchasing
Support Services Group
Central Subcontracting
Office

Raisa Budman
Senior Analyst Programmer
Student Information
Systems

Carolyn A. Bunker
Bursar
Office of the Dean of
Students and
Undergraduate Education

Laura Capone
Project Manager
Undergraduate Education
Student Affairs Operations
and Administration

Christine Cavanna
Senior Financial Business
Analyst
Telecommunications
Systems

Alexander S. Chisholm
Major Gifts Officer
Office of Individual Giving

Rocklyn E. Clarke
Senior Systems
Programmer
Service Process

William H. Comstock
Technical Supervisor,
Document Services
Libraries

Daniel P. Conceison
Supervisor, Dormitory
Patrol
Housing

William T. Conley
Associate Director, Lincoln
Property Office
Lincoln Fiscal Office

Martha A. Connors
Director of Marketing and
Circulation, Technology
Review
Alumni Association

Traci Trotzer Considine
Staff Associate, Task Force
On Student Life and
Learning
Office of the Dean of
Students and
Undergraduate Education

Joseph A. Contrada
Manager, Muddy Charles
Pub
Graduate Education Office

Elizabeth D. Cooper
Director
Administrative Services:
Department of Chemical
Engineering and
Department of Materials
Science and Engineering

Thomas J. Coppeto
Senior Systems
Programmer
Service Process

Nancy Murphy Crosby
Administrative Assistant
Office of the Dean of
Students and
Undergraduate Education

Daniel A. Crovo
Coach, Repair and
Maintenance
Physical Plant

Robert M. Damian
Contract Administrator
Office of Sponsored
Programs

Robert M. Dankese
Assistant Director
Office of Budget
and Financial Planning

Kacey B. Davenport
Assistant Director of
Admissions
Admissions Office

Anthony Davis
Senior Contract
Administrator
Housing

Emerson P. Davis
Auditor
Reengineering-
Management Reporting

Ruth T. Davis
Publications Manager,
Communications Office
Public Relations Services

Robin M. Deadrick
Personnel Administrator
Libraries

| | | | |
|------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Robert B. Dimmick Coordinator, Reunions and Special Events Alumni Association | Michael W. Foley Associate Director of Operations Campus Activities Complex | Karen Harnett Gribbell Associate Director of Master's Program Sloan School of Management | Thomas S. Hoole Assistant to the Director for Purchasing Methods and Procedures the General Purchasing Department |
| Steven M. Dimond Manager Copy Technology Centers | Christine R. Ford Manager, National and International Alumni Screening Effort Office of Development Research and Systems | Danielle Guichard- Ashbrook Assistant Dean, International Students Office Graduate Education Office | Deborah R. Hopkins Program Manager, Alumni Activities Alumni Association |
| Patricia A. Dixon Administrative Officer Department of Civil and Environmental Engineering | Eileen M. Francis Budget Officer Office of Budget and Financial Planning | Carl W. Hagge Coach, Repair and Maintenance Physical Plant | Marianne L. Howard Director of Personnel for Benefits and Systems Personnel Office |
| Robert L. Donaghey Manager, Personnel Administration Physical Plant | Sharon D. Francis Assistant to the Vice President for Finance and Treasurer Reengineering-Vice President for Finance and Treasurer | Robert L. Harris Supervisor/ Coach, Building Services Physical Plant | Stanley G. Hudson Director of Student Financial Aid Office of the Dean of Students and Undergraduate Education |
| John P. Donahue Assistant Accounting Officer Office of Sponsored Programs | Richard J. Frye Purchasing Broker, Publishing Services Bureau Public Relations Services | Howard D. Harrison Coach, Repair and Maintenance Physical Plant | Stephen D. Immerman Director of Administration and Operations Office of the Dean of Students and Undergraduate Education |
| Mary T. Donovan Accounting Officer Controller's Accounting Office | Martha Jane Gagnon Auditor Audit Division | Paul Heffernan Software Acquisition Coordinator Vice President for Information Systems | Shyamal A. Jajodia Auditor Reengineering- Management Reporting |
| Tammy L. Doyle Coach, Repair and Maintenance Physical Plant | David E. Geist Associate Technology Licensing Officer Technology Licensing Office | Michael J. Hegarty Licensing Associate Technology Licensing Office | Glenn Johnston Senior Consultant Sloan School of Management |
| Regina Dugan Insurance and Legal Affairs Office of the Senior Vice President | Joseph F. Gifun Manager, Repair and Maintenance Physical Plant | Arnold R. Henderson, Jr. Associate Dean and Section Head, C S S Office of the Dean of Students and Undergraduate Education | Elizabeth Karagianis Senior Editor, Communications Communications and Donor Relations |
| Shawn P. Dunn Analyst Programmer Office of the Bursar | Patricia J. Gilardi Senior Analyst Programmer Reengineering- Management Reporting | David H. Henshaw Assistant to the Controller for Special Studies Office of Sponsored Programs | Maria Karatzas Senior Contract Administrator Office of Sponsored Programs |
| Ellen F. Duranceau Librarian Libraries | Stephen L. Gilligan Analyst Programmer Office of Development Research and Systems | Sarah J. Hernandez Assistant to the Bursar, Control and Accounting Office of the Bursar | Charles Lee Katin Coach, Repair and Maintenance Physical Plant |
| Nancy A. Dykstra Assistant to the Vice President for Finance and Treasurer Reengineering-Vice President for Finance and Treasurer | George J. Gillis Supervisor/ Coach, Building Services Physical Plant | Paul B. Hill Senior Analyst Programmer Service Process | Charles Lee Katin Supervisor/Coach, Repair and Maintenance Physical Plant |
| Gillian C. Emmons Assistant to the Vice President for Finance and Treasurer Reengineering-Vice President for Finance and Treasurer | Barrie B. Gleason Director, Communications Office Public Relations Services | Richard A. Hill Director and Head of Athletics, Physical Education and Recreation Office of the Dean of Students and Undergraduate Education | Joseph A. Kay Coach, Repair and Maintenance Physical Plant |
| Eric P. Epstein Coach, Repair and Maintenance Physical Plant | Christina M. Gonzalez Analyst Programmer Lincoln Fiscal Office | Jon W. Holcombe Senior Research Analyst, Resource Development Office of Development Research and Systems | Martin J. Kelly Investment Analyst Treasurer's Office |
| Talitha Fabricius Landscape Architect/Project Manager Physical Plant | Margaret Ann Gray Manager, Training and Development Personnel Office | Kevin G. Holland Alumni Affairs Officer Alumni Association | Joseph D. Keohan Business System Analyst Property Office |
| Deborah L. Fairchild Associate Director Office of Budget and Financial Planning | Stephanie V. Grepo Staff Writer/ Editor Alumni Association | | Susan R. Keohan Senior Analyst Programmer Reengineering- Management Reporting |

| | | | |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Ori Kometani Designer MIT Press | Karon S. McCollin Senior Business Systems Analyst Reengineering- Management Reporting | Karen A. Nilsson Executive Administrator Physical Plant | Christopher Salter Coach, Repair and Maintenance Physical Plant |
| Theodore H. Korelitz Senior Industrial Liaison Officer Industrial Liaison Program | Monica McConnell Alumni Affairs Officer Alumni Association | Robert T. Norton Supervisor/ Coach, Building Services Physical Plant | Helen W. Samuels Projects Coordinator Office of the Provost |
| Kathleen M. Lalor Assistant to the Controller Controller's Accounting Office | Margaret M. McGrath Purchasing Agent The General Purchasing Department | Michael Kobina Owu Planning Officer Planning Office | Emily B. Sandberg Assistant Dean Public Service Center Office of the Dean of Students and Undergraduate Education |
| Carla P. Lane Team Leader/Member Vice President for Administration | Theodore McCabe, Jr. Systems Programmer The Network Business | Barbara Peacock-Coady Team Leader/Member Vice President for Human Resources-Reengineering | Linda J. Scatamacchia Auditor Reengineering- Management Reporting |
| Theresa J. Lee Alumni Affairs Officer Alumni Association | Laura B. Mersky Assistant to the President Office of the President | Linda G. Peterson Director, Academic Programs Administration Program in Media Arts and Sciences | Beth Ann Scheid Assistant Director Student Financial Aid Office |
| Joseph F. Lendall Senior Subcontract Administrator the General Purchasing Department | Darlene Messmer-Slagle Contract Administrator Office of Sponsored Programs | Austin H. Petzke Manager, Building Services Physical Plant | Amy Schrom Alumni Affairs Officer Alumni Association |
| Carmen Lepore Coach, Repair and Maintenance Physical Plant | Anne Marie Michel Associate Director, Foundation Relations and School Development Services Office of Foundation Relations | Reid M. Pinchback Senior Analyst Programmer Delivery Process | Margaret Scoppa Coordinator, Educational Services Sloan School of Management |
| Milena M. Levak Associate Dean and Section Head, I S O Graduate Education Office | Kevin J. Milligan Associate Director Property Office | Paul Joseph Pino, Jr. Supervisor/ Coach, Building Services Physical Plant | Warren E. Scott Coach, Repair and Maintenance Physical Plant |
| Robert J. Lewis Director of Personnel for Employee Relations Personnel Office | Phoebe Minias Assistant Registrar, Catalogue and Publications Registrar's Office | Laxmi J. Rao Project Manager - Utilities Physical Plant | Eleanor Shavell Analyst Programmer Delivery Process |
| Wai-Ming Li Analyst Programmer Reengineering- Management Reporting | Stephen P. Miscowski Manager, Repair and Maintenance Physical Plant | Judy Kay Raymond Compensation System Specialist Personnel Office | Diane J. Shea Associate Director of Purchasing The General Purchasing Department |
| Laura Costa Lucas Training Coordinator Physical Plant | Paul M. Mitchell Supervisor/ Coach, Building Services Physical Plant | Theresa M. Regan Director, Office Computing Vice President for Information Systems | John M. Sherwood Senior Industrial Liaison Officer Industrial Liaison Program |
| Michal N. Lusztig Senior Systems Programmer Service Process | Paul Motroni Coach, Repair and Maintenance Physical Plant | Robert A. Rippondi Director, Student Information System Office of the Dean of Students and Undergraduate Education | Debbie H. Shoap Associate Director, Educational Services Sloan School of Management |
| Colin Maclaurin Senior Major Gifts Officer Office of Individual Giving | Ayida Mthembu Associate Dean, Counseling and Support Services Office of the Dean of Students and Undergraduate Education | Iria J. Romano Assistant Registrar, Student Information Registrar's Office | Ellen M. Sico Accounting Officer Controller's Accounting Office |
| Heather M. Madnick Assistant Director, Undergraduate Program Sloan School of Management | Thomas E. Mullen Director of Federal Cost Studies Office of Sponsored Programs | Yvonne M. Romero Assistant Director of Admissions Admissions Office | Jacqueline R. Simonis Associate Dean, Counseling and Support Services Office of the Dean of Students and Undergraduate Education |
| Jennifer R. Mapes Assistant Director, Management of Technology Programs Sloan School of Management | John C. Narcotta Coach, Repair and Maintenance Physical Plant | Paul C. Rudack Coach, Repair and Maintenance Physical Plant | Elizabeth M. Simons Alumni Affairs Officer Alumni Association |
| Richard F. Marsh Coach, Repair and Maintenance Physical Plant | Steven Wade Neiterman Senior Analyst Programmer Delivery Process | Lisa Marie Rung Assistant Registrar, Facilities and Scheduling Registrar's Office | Richard J. Sirois Coach, Repair and Maintenance Physical Plant |
| | | Alison M. Salie Financial Officer Department of Biology | |

Stephen A. Skuce
Librarian
Libraries

Lori J. Smith
Manager of Donor
Relations
Communications and
Donor Relations

Cynthia S. Souza
Facilities Information
Manager
Office of Facilities
Management Systems

John R. Squillante
Performance Consultant
Vice President for Human
Resources-Reengineering

Lisa J. St Croix
I/T Trainer
Physical Plant

Joanne Y. Stevenson
Associate Director, Student
Information Systems, Senior
Project Leader
Student Information
Systems

Paul L. Sweeney
Associate Intellectual
Property Counsel
Office of Sponsored
Programs

Christopher Sean
Tappendorf
Consultant
Support Process

Brian E. Tavares
Auditor
Audit Division

Michelle Thresher
Financial Services Manager
Treasurer's Office

Mary M. Tobin
Coach, Repair and
Maintenance
Physical Plant

Neil D. Tomlinson
Coach, Repair and
Maintenance
Physical Plant

Theodore Ts'o
Senior Systems
Programmer
Integration Process

Marshall J. Vale
Analyst Programmer
Service Process

Cynthia L. Vallino
Project Manager
Vice President for Human
Resources-Reengineering

Maryglenn Vincens
Senior Major Gifts Officer
Office of Individual Giving

Kimball C. Warren
Consultant
Reengineering-
Management Reporting

Alice C. Waugh
Staff Writer/ Editor
Public Relations Services

Laurie A. Way
Senior Research Analyst,
Resource Development
Office of Development
Research and Systems

Kenneth R. Weekes
Assistant Bursar, Loan
Programs
Office of the Bursar

Jonathon Weiss
Systems Programmer
Delivery Process

Roberta R. Welch
Administrator,
Undergraduate Degree
Audit
Registrar's Office

Anne Hartung Whealan
Assistant Director of
Budget and Financial
Planning
Office of Budget and
Financial Planning

Priscilla Woolery
Senior Research Analyst,
Resource Development
Corporate Development

Karen T. Wilcox
Assistant Director, Student
Financial Aid Office
Student Financial Aid
Office

John S. Wilson
Assistant Provost for
Outreach, Director of
Foundation Relations and
School Development
Services
Resource Development
Vice President

Gail F. Wood
Supervisor/ Coach,
Building Services
Physical Plant

Brima A. Wurie
Assistant to the Dean
Graduate Education Office

William W. Yorston
Supervisor/ Coach,
Building Services
Physical Plant

Grant A. Young
Systems Programmer
Service Process

Elena Zhitnikov
Data Administrator
Integration Process

PUBLIC RELATIONS SERVICES

The mission of Public Relations Services is to help enhance public understanding and support of MIT, and of higher education and research more generally, and to enhance the community life of the Institute through communications and special events. The past year saw a number of significant transitions in organization and operations.

Following in-depth reviews of changing publishing needs and of the savings that could be obtained through supplier consolidation, it was announced at the beginning of the fiscal year that the Office of Design Services, as well as the offset printing, photographic, and illustration operations in the Graphic Arts Department, would be closed and that a new Publishing Services Bureau (PSB) would be established to coordinate the design and production of the Institute's publications.

Reporting jointly to the Director of Public Relations Services and to the Senior Vice President, the new Bureau assists departments in the planning of both print and electronic publications, matches Institute publishers with appropriate outside vendors, and acts as purchasing agent for all MIT publications-related purchases. An intensive search process resulted in the selection of Bruce Bernstein as Director of the Bureau. As Associate Director of Admissions, he had previously been responsible for award-winning publications that have contributed greatly to the Institute's success in recruiting the country's most talented college applicants. Barrie Gleason, Director of the Communications Office, gave unstintingly of her time in the study process that led to the creation of the Bureau and in the months in which it took shape.

The distinguished standards they set for Institute publications will be an enduring legacy from the many talented people in the Office of Design Services. Great thanks are due to departing Director Celia Metcalf and her staff for their assistance in the transition period during the fall and winter preceding the opening of the PSB.

Retirements under the Institute's special retirement incentive program meant the departure of three greatly respected senior staff from the News Office. In the wake of these departures, director Kenneth D. Campbell worked to reorganize office operations, recognize the accomplishments of current staff, and hire new personnel from outside the Institute to handle the Office's demanding workload.

Staff in Public Relations Services play vital roles in the Institute's great annual ritual of transition at Commencement; this year they also managed a very special community celebration in honor of Dr. Paul E. Gray and Mrs. Priscilla K. Gray, marking the close of Dr. Gray's service as chairman of the MIT Corporation.

In the Director's office, Gina S. Kent left to move with her family away from the Cambridge area, and Michael A. Baenen, formerly in the Dean's Office in the School of Architecture and Planning, assumed the responsibilities as Administrative Assistant.

The Director devoted much of her own effort to ongoing and new initiatives designed to bring together those with a responsibility for communications activities in individual departments across the Institute. The informal Public Relations Working Group and the larger Information Group continued to serve as sounding boards on current issues and initiatives as well as forums for news and ideas. A December retreat that included twenty leaders in the Institute's faculty and administration helped staff in the President's Office as they studied the establishment of a new senior communications position reporting to the President, the search for which was expected to begin as the year 1997-98 began.

Kathryn A. Willmore

COMMUNICATIONS OFFICE

The Communications Office publishes official reference information on MIT's educational, research, administrative, and financial policies and programs that is current, accurate, and accessible, in print and electronic versions; distributes publications and disseminates information available through the office. In conjunction with the Publishing Services Bureau (PSB), the Office advises and assists the MIT community regarding publishing policies and procedures.

HIGHLIGHTS OF THE YEAR

Staff in the Communications Office have established a strong record of support for the Institute's change efforts by participating on reengineering teams charged with redesign of MIT's publishing services and at the same time managing publishing business-as-usual. This year saw a milestone event in these efforts: approval by senior administration of the new Publishing Services Bureau and the hiring of its director in October 1996.

PSB's business plan clarifies the vision for a new way of doing business, which includes a "strategic alliance" with the Communications Office. In its role as customer of and partner with the Bureau, the Communications Office will provide advice to other departments as well as utilize innovative information management in the production and distribution of the Institute's core reference publications.

Second, in collaboration with Information Systems, the Office completed the discovery phase of its project to publish the "blue pages" of the telephone directories on-line. Information on MIT's offices and programs will be stored in a database, from which staff can produce a World Wide Web version (updated on an ongoing basis) and print version (published annually).

Third, the Office continues to work closely with offices in student services to review the publications that currently serve undergraduate and graduate students, an effort that entails understanding how these communications work, how they work together, and the extent to which they are effective.

Fourth, since the presence of the *Reports to the President* on the World Wide Web gives it a much wider audience, the Communications Office distributed a comprehensive set of style guidelines to authors this year. These guidelines will help to ensure that the Institute publishes annual reports that present information in a consistent fashion.

Finally, there were innovations in the cover design for three publications. The Directory covers featured the work of Felice Frankel, artist-in-residence at MIT's Edgerton Center and visiting lecturer in Course 6, and of one of her students. The cover of the *MIT Bulletin 1997-98*, featured a lively new image of Lobby 7, created by designer Tim Moore, which earned rave reviews. The Office produced a poster of the original, which has been used widely by administrative offices for gifts and tokens of appreciation, and is on sale at various campus locations.

FUTURE PLANS

The Communications Office plans the following for the new fiscal year:

- Move to new physical location with PSB and Campus-Wide Information Systems. As PSB's partner, continue to explore publishing initiatives such as (1) design of an organization chart for the World Wide Web that works as a "who's who" of the Institute; (2) editorial style guidelines to inform work of Institute publishers as well as Bureau staff and vendors; and (3) promotion and use of the publication plan.
- Publish directory "blue pages" information in versions appropriate for internal and external audiences, for print and the World Wide Web.
- In conjunction with offices in student services, establish priorities and begin work on publishing catalogue information on the World Wide Web (complementing the Registrar's MIT Subject Listings and Schedule).

PERSONNEL CHANGES

Administrative staff stepped into "larger shoes" this year when they received promotions within the Communications Office: Ruth T. Davis, from Editor and Production Manager to Publications Manager; and Barrie Gleason, from Manager to Director, Communications Office. After many years of service at MIT, Marianne Charny left with her family for Cambodia, where her husband accepted a position with the United Nations. The Office welcomed a talented new contributor to the team, Shannon McCord, in November.

More information about the Communications Office can be found on the World Wide Web at the following URL:
<http://web.mit.edu/communications/www/>

Barrie Gleason

CONFERENCE SERVICES, EVENTS AND INFORMATION CENTER

The office's mission is to meet the informational 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

During the past year, the Center served as a point of information and welcome to visitors, as well as a central information source for members of the MIT community. Staff in the center distributed over 46,400 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 campus tours was Alif Chaudhry, '97, in the Department of Aeronautics and Astronautics, who handled the scheduling of the tours while Terri Priest, staff associate in the Center, trained 23 student guides who conducted tours for 13,142 visitors, of whom 4,529 were prospective students, 1,665 international visitors, and the remaining guests visiting MIT. Terri Priest arranged programs for 49 short-term visits which brought 781 guests to campus. The coming year will see a more concentrated focus on the short-term visits by Ms. Priest.

The Center also handled the arrangements for more than 200 recruitment presentations by companies and other organizations that visit MIT under the auspices of the Office of Career Services and Preprofessional Advising.

In the realm of community events, the Hooding Ceremony for 390 doctoral degree recipients, held in Rockwell Cage the afternoon before Commencement, was once again a success. Over 70 faculty members representing all the departments were on hand to help celebrate, as dean for graduate education J. David Litster and the relevant departmental representative presented each candidate with his or her doctoral hood.

The 131st Commencement Exercises were enhanced by the presence of alumni and alumnae returning for reunions and Technology Day. His Excellency Kofi Annan, Secretary-General of the United Nations, was the guest speaker, and President Vest gave the charge to the candidates and a salute to Paul E. Gray, who presided over his final Commencement as Chairman of the MIT Corporation. Killian Court was sunlit and the day extraordinary for 2,280 seniors, graduate students, alumni and alumnae, family and friends.

The Center assisted with the logistical arrangements for the Annual Retirement Dinner in September in the Johnson Athletics Center, the Fiftieth Anniversary of the Research Laboratory of Electronics in November, the Dedication of the Rosalind Denny Lewis Music Library in December, the Community Celebration for Paul and Priscilla Gray on 8 April, and the Lemelson-MIT Prize Ceremony in Washington, D.C. on 10 April. This year's Killian Award Lecture, delivered by Professor Gian-Carlo Rota, was held on 5 March. Sadly, memorial services were arranged for Gordon S. Brown and Thomas S. Kuhn in November.

CONFERENCE SERVICES

The office of Conference Services manages the logistical arrangements for conferences and meetings sponsored by MIT faculty and staff. This past year, the Office coordinated 25 such events – ranging in size from 10 to 2,000 – which brought more than 10,000 visitors from all over the world to the campus. These included the Global Accords Symposium, the International Conference on Carbon Dioxide Removal, the British Approval Board of Telecommunicators meeting, the Whitehead Institute Annual Symposium, the North American Power Symposium, the Participatory Design Symposium, the Alliance for Global Sustainability Symposium, the American Computer Experience Summer Camp, Oxford Study Program, Regent Language Training Program, the Massachusetts Special Olympics Summer Games, the English/Japanese Exchange Program, Career Connection Fair, the New England Conference on Technology and Education, Massachusetts Future Problem Solving Bowl, Massachusetts Biotechnology Council Symposium and Exposition, the AAU Deans Meeting, and a Symposium for Senior Congressional Staff.

This year the office began collaboration with the Industrial Liaison Program in providing assistance with their conference management. The events included conferences on Distance Learning, Design Studio, Intellectual Property, and the Annual Research Directors Meeting. We look forward to increasing this collaboration in the coming year and to further enhancing the registration capabilities via the World Wide Web for all events. The

Conference Services staff has responsibility for the events registration process for non-student events; this year 150 applications were approved.

PERSONNEL

The Center, under the direction of Gayle Fitzgerald, includes Kathleen Barrett and Terri Priest as Staff Associates for information dissemination, tour operations and short-term visits; Donald Ferland as Administrative Secretary to the Director with responsibilities for Commencement and the recruitment presentations; Cathi Di Iulio and Marie Seamon, Conference Coordinators; and Brian McCarthy who provides database assistance to Cathi and Marie within the Conference Services Office. Brian replaced Tara Osborn who left MIT in February.

Gayle M. Fitzgerald

NEWS OFFICE

The mission of the News Office is to achieve the highest level of public interest in MIT by finding and reporting newsworthy stories and photographs about MIT and its people; encouraging and assisting reporters to develop their own stories here; publishing the official newspaper, *MIT Tech Talk*; monitoring internal and external developments that might bring favorable or unfavorable public attention, and handling them with integrity in the best interest of MIT.

HIGHLIGHTS

This has been a year of constant change in the News Office. It began with a retirement party for three veteran staffers, Joanne Miller, Charles Ball and Robert DiIorio, who left behind them 85 years of experience in the News Office. Despite being short three administrative staff, the News Office undertook two very ambitious projects: publicity for the BankBoston study of the economic impact of MIT graduates, released in March, and compilation of a Medical Experts Guide to the research interests of nearly 200 faculty and research staff, which will be published in August of 1997. In addition, of the 33 issues of *MIT Tech Talk* published, six were 12-page issues (including one on October 30 that featured a four-page special section on the 50th anniversary of the Research Laboratory of Electronics). Nearly 100 press releases were issued and *MIT Research Digest* was published 11 times.

NEWS STORIES

The News Office produced numerous press releases and *Tech Talk* stories in 1996-97 on ground-breaking research and MIT's overall impact. Among the most significant was the January story on the world's first atom laser developed by Professor Wolfgang Ketterle and colleagues. The device, a long-sought goal in physics, is analogous to an optical laser but emits atoms instead of light. The atom laser could have a variety of applications in fundamental research and in industry, doing for tasks involving atoms what the optical laser did for light. In March, the News Office and BankBoston released *MIT: The Impact of Innovation*, the first national study of the economic impact of a research university. BankBoston reported that graduates of MIT have founded 4,000 firms which, in 1994 alone, employed 1.1 million people and generated \$232 billion of world sales. If those companies founded by MIT graduates and faculty formed an independent nation, their revenues would make that nation the 24th-largest economy in the world, the report noted.

Headlines of other important MIT stories included the following:

- Tiny "livers" are grown in the laboratory – May 22, 1996
- Gels contract and expand in response to magnetic fields – June 12, 1996
- MIT projects win Discover awards – June 12, 1996
- Implant wafer approved for brain cancer treatment – October 2, 1996
- Tissue-engineering experiment aboard Mir blazes trail – October 23, 1996
- Computer science facilities to be in new complex – December 18, 1996
- Landmark study reveals mouse memory mechanism – January 8, 1997
- Protecting babies from airbags – January 15, 1997
- MIT Sea Grant's underwater robot to search for giant squid – January 29, 1997
- "Penguin boat" plies the Charles – April 3, 1997
- Ring monitors vital signs, location of patients in home – April 3, 1997
- Three from MIT are winners of Discover finalist awards – June 11, 1997

PHOTOGRAPHY

The News Office sent out or responded to requests by the local, national and world media for 70 different photographs taken by News Office photojournalist Donna Coveney including research stories, feature stories, portraits of faculty, Commencement, and general campus shots. The Associated Press, which provides photographs to newspapers and television as part of its world-wide news service, is our largest customer.

The most frequent requests for photos were for Wolfgang Ketterle's atom laser research (17, including *Time*, *The Washington Post*, AP, *Science* and *Vie*, *The Chronicle of Higher Education*, Knight-Ridder, *Panorama*, *Industry Week* and *The Boston Globe*). Other major stories were the Penguin boat (15 requests, including *National Geographic*, *Der Spiegel*, *Discover*, *Popular Science*, *Wired*, *New Scientist*, *R&D* magazine, and *The Boston Herald*); Robotuna (10 requests); James McLurkin and his Robotic Ants (10 requests); the finger ring for patient care monitoring from Professor Harry Asada's lab (seven requests including *R&D* magazine, *Focus* magazine, and *Newsday*). Other publications ordering photos from Donna and photo clerk Mary Anne Hansen included *Jet*, *Ebony*, *The Chronicle of Higher Education*, *Discover* magazine, *Chemical and Engineering News*, the *Dallas Morning News*, and *The Los Angeles Times*. The Black Physics Students conference went out to AP, and select magazines and newspapers.

In addition, the News Office sent out to the AP, *The New York Times* and *The Boston Globe* and *Boston Herald* many archival and historic photographs provided by the MIT Museum or the MIT Archives, usually in connection with an obituary written by the News Office.

PERSONNEL

The News Office also did a study of its staffing needs, concluding that the office needed a second science writer and an additional support staff person. The Administration in September approved the additional resources for news about MIT.

A new associate director, Robert J. Sales, former executive editor of the *Boston Herald*, was hired in December, and took over much of the writing of articles for *Tech Talk*. Kathleen Rowe, assistant director for media relations since 1993, left MIT to take a job with a public relations firm. Also in December, Alice Waugh, assistant editor/staff writer for the previous three years, moved smoothly into the editor's chair and performed the editing and layout for *Tech Talk* by herself during all of 1996-97. Sarah Wright was hired in March as a temporary staff writer and in June, took on additional duties for science writing and PR because of the maternity leave of Elizabeth Thomson, assistant director for science and engineering news, who split her work this year between news, editing stories for the *Research Digest*, and the painstaking editing of the medical expert guide. Elizabeth gave birth to Marc Edward Plageman on June 1. Donna Coveney, assistant director and staff photojournalist, entered the digital age in June with new computer equipment for negative and slide scanning and editing. Mary Anne Hansen, with the office since 1995, was promoted in March to administrative secretary, a new position. LaKeitha Evelyn, a recent graduate of Simmons College and former staff member in constituent services and accounting at Boston City Hall, joined the office in May as senior office assistant and receptionist. Thanks are due to Mary Anne Hansen; Lisa Damtoft, design and editorial assistant and production manager for the *Research Digest*; and Myles Crowley, administrative assistant and office/computer manager, all of whom took on additional work in this transitional period with true professionalism and spirit. Also, special thanks to Stephanie Gellar, MIT '94, for work above and beyond the call of duty on the medical experts guide this past year. Stephanie's part-time work for the News Office over four years ended June 30. Denise Brehm, administrative assistant and writer in Civil and Environmental Engineering since 1994, will join the News Office in July 1997 as an assistant editor/staff writer. Three other positions were expected to be filled early in the fall.

More information about the News Office can be found on the World Wide Web at the following URL:
<http://web.mit.edu/newsoffice/www/>

Kenneth D. Campbell

PUBLISHING SERVICES BUREAU

The Publishing Services Bureau opened its doors the first week of February, providing a single coordinated channel for publishing activities across the Institute, applying the principles of supplier consolidation, strategic planning, technological awareness, cost savings, excellence in design, continuous learning, and customer satisfaction.

HIGHLIGHTS OF THE YEAR

Nine individuals were hired by the director to form the core of the PSB team. Six had worked previously at MIT. Rick Frye, Jean Caloggero, and Andy Barnes, representing the Purchasing Office for graphic arts now comprise the purchasing component of PSB. Brian Ellis, assistant broker, was formerly an administrative assistant in the Educational Council Office and Robin Dey, administrative assistant, previously worked in Admissions. Kate Miller, electronic broker, returned to MIT after working two years as a project coordinator for a Cambridge-based consulting firm.

Three team members are new to MIT. Tim Blackburn, designer, was an associate at Sametz Blackstone; Kelly Powell, print/design broker, was an operations manager from Northeastern's publications department; and Elizabeth Brinkerhoff, print/design broker, was an instructor in the graphics design program at the University of Memphis.

Within five months, PSB coordinated the production of over 600 jobs. With the help of a new database, the Bureau now tracks all aspects of publishing activities for jobs passing through the Bureau, creating both a baseline for the analysis of design, production, and printing costs as well as the creation of an archived job history.

As part of an initial promotional campaign, PSB created an "under construction" Web site that garnered enthusiastic responses from across campus and a capabilities brochure that won a CASE silver "Circle of Excellence" award for low-cost publications.

PSB also began the first step in the supplier consolidation process by mailing a "Request for Solutions" to nearly 500 print vendors and 150 design vendors. By the end of June, the office had received proposals from nearly 250 print vendors and 100 design and creative vendors.

PSB partnerships with both the Communications Office and Campus Wide Information Systems have led to the exchange of ideas and information about related business processes and aligned planning activities, providing seamless support interface for MIT customers in the area of electronic publishing and strategic print planning.

PSB has coordinated nearly 15 electronic publishing projects with CWIS and has collaborated on several variations of the main MIT home page. Pursuing the concept of "offices with invisible walls," CWIS maintains two desks in the Bureau space and shares computer and software resources.

Strategic alliance with the Communications Office has led to a relationship in which PSB plays a role as both a broker and a partner; in addition to advising Communications on their own publishing projects, the organizations have joined together to model and publicize effective publishing processes. Ongoing efforts include publication plan projects for Leaders for Manufacturing, Student Services, the Planning Office, and the Admissions Office.

Other partners at MIT include the Copy Technology Center, Mail Services, and Document Services, with PSB working to promote the services of these groups at MIT and establish smoother lines of communication and workflow.

As part of its effort to establish equity in an MIT identity system, PSB has taken on several projects to design publications for high-level or high-visibility publishing efforts. These projects will be developed into templates for the entire MIT community. The Freshman Handbook, the Freshman Advising Seminar Guide, the MIT Museum awareness card, and a new logo for the Minority Introduction to Engineering and Science program, as well as a coordinated letterhead/business card system for several student services departments, will be a springboard for future PSB work with the MIT identity.

FUTURE PLANS

- Move into new space with the Communications Office and CWIS.
- Continue to promote good publishing practices exemplified by extraordinary design standards and economy of production.
- Continue to promote community understanding of both the PSB mission and good publishing practices through the use of its Web site, instructional seminars, community outreach initiatives, and joint Communications Office and CWIS partnership.
- Establish partnerships with selected print and design vendors.
- Develop an on-line catalog system for the production of letterhead, envelopes, and business cards as well as develop templates for the use of MIT publishers.
- Conduct a series of workshops coordinated and facilitated by the IS training and publication services team to examine a “balanced scorecard” approach to evaluating PSB services.

PERSONNEL CHANGES

At the end of June, Robin Dey left PSB to spend her summer studying desktop publishing and in September will begin as a marketing intern for a local architectural firm. PSB is currently conducting a search for a new administrative assistant.

More information about the Publishing Services Bureau can be found on the World Wide Web at the following URL: <http://web.mit.edu/psb/>

Bruce Bernstein

PROVOST

NEW APPOINTMENTS AND PERSONNEL CHANGES

The Early Retirement Plan for the faculty saw the retirement of three Institute Professors - Morris Halle, John Waugh, and Hermann Haus. Professor Haus continues on the faculty on a 49% part-time basis. Three new Institute Professors were appointed in the Spring - Peter Diamond of Economics, Thomas Magnanti of Sloan and Electrical Engineering and Computer Science, and Mario Molina of Earth, Atmospheric and Planetary Sciences as well as the Chemistry Department. Institute Professor John Deutch returned from government service, most recently as Director of the CIA. Late in the academic year it was announced that Institute Professor David Baltimore will leave to become President of the California Institute of Technology.

John Wilson, Director of Foundation Relations, has also been appointed Assistant Provost for Outreach. In this new position he will work to enhance the relations between MIT and historically black colleges and universities.

Helen Samuels, the Archivist of the Institute, left that position and will now work with Associate Provost Philip Clay on policy issues related to maintaining information about students.

Stefano Falconi was appointed the Director of the Office of Budget and Fiscal Planning. This Office has a dotted line relationship to the Provost's Office.

POLICY CHANGES

The Education Committee is a subcommittee of Academic Council that is chaired by the Provost. The Education Committee proposed several changes to policies of the Institute:

- Senior Research Associate positions have been made with three-year rolling tenure. Since funding has become more constrained in recent years, department heads and laboratory directors have become less willing to make appointments with such a lengthy period of guaranteed support. The Committee proposed making the normal period one year, and permit longer periods on an exceptional basis.
- The rank of Adjunct professor has served the Institute very well for many years. There have been situations where the title or the single rank have been too constraining. The Committee proposed permitting the rank of Professor of the Practice to be equivalent to the rank of Adjunct professor. In addition, the rank of Adjunct Associate Professor and Associate Professor of the Practice was introduced. Finally, the length of the initial appointment to these ranks, currently three years, has been permitted to be lengthened. The total number of all such appointments has, however, been kept as at present.
- The cost of an RA, under the new scheme for paying RA tuition that is to go into effect in FY99, was reanalyzed. This led to a number of proposed changes. The original scheme for RAs had the Provost pay 45% of the RA tuition. This would have led to an increase in the overall cost of an RA of about 13%. The new scheme will have the Provost pay 30% of tuition as well as 30% of the stipend of an RA. This results in an increase for RAs of only 4%. A side-effect of the proposed change is to increase the overhead rate by 5.5 points. This would have led to a Facilities and Administration (overhead) rate of about 70%. In order to reduce the rate to the mid or low 60's, a number of additional changes are being considered. For example, equipment above \$500 are currently not overheaded. In the revised scheme the limit would be raised to \$3000.

FINANCIAL MATTERS

The Provost as Chief Budget Officer spends a significant amount of time on the Institute's budget plans. Historically, several offices at MIT have been involved in decisions that have a nontrivial impact on the budget. For example, the Student Financial Aid Office makes proposals for the tuition rate for the following year, and the Personnel Office makes recommendations on average salary increases in various categories. This year we have created a new committee, the Budget Planning Committee of about sixteen members, which has met every other month during the academic year in order to review various information that affects the budget for future years. It is hoped that a better flow of information can lead to better control over the budget.

The Provost, working with the Office of the Budget and Fiscal Planning, has developed a model that looks ahead ten years. The model concentrates on unrestricted funds. Unrestricted funds are only one third of the total Institute budget, but the operating deficit is the same whether one looks at the total budget or just at the unrestricted funds. Thus it is hoped that this approach is easier to analyze and understand. In addition, the Provost, working with an outside consultant, has created a large systems dynamics model of the Institute. In such a model it is possible to consider the effects of increased capital expenditures, for example, on both the future size of the endowment and the attractiveness of the Institute to potential new faculty and students. It is hoped that such a model will provide an intuitive understanding of the implications of changes in the way the Institute expends funds.

Research volume at MIT has been relatively flat and actually declining in real terms for several years. The administration has made efforts to build up research support in two areas - industry and international. These have begun to pay off. It is anticipated that we will end the year with industrial sponsored research growing at about 12%, and with overall research growth at about 5%. We expect these efforts to pay off in future years as well. A key measure of the impact of increased research support on the deficit is the growth in the Modified Total Direct Cost base. This figure has, unfortunately, not grown as fast as total volume, and is clearly an area to which we need to pay increased attention in the coming years.

The Technology Licensing Office has had a banner year, with gross income above \$20M for the first time. Over \$5.5M was raised when RSA, Inc. was sold to a public company, and when Cambridge Heart became a publicly held company. Most of the proceeds from the sale of the stock in these firms was used to endow the RSA, Inc. chair, and the Distinguished Professorship in Health Science and Technology (HST).

CONSTRUCTION/RENOVATION

Many of the major renovation activities on campus are related to the need to find space for the current occupants of Building 20. Building 20 is still due to be taken down in the first half of 1998. Building 56 was renovated and occupied in this fiscal year. Major work is now going on in Building 16. Both buildings were vacated when the Biology building was completed. Many of their new occupants will be associated with the Chemical Engineering and Chemistry departments, the Toxicology Division, and the HST Division. The MIT Press headquarters was moved off-campus in order to give temporary space for the Department of Linguistics and Philosophy. Other current occupants of Building 20 are to be housed in various parts of the campus.

Fund raising for the new buildings on the site of Building 20 reached a major milestone when the Ray and Maria Stata gift was announced. Pledges now total \$15M. In addition, the estimated value of the rents in Technology Square that will no longer be needed is about \$35M. The estimated cost of the new buildings will be about \$90M. Thus fund raising is continuing.

Senior House was renovated during the summer of 1996. The renovation of the outside of the building will be completed in the summer of 1997.

The Rosalind Denny Lewis Music Library was dedicated in the fall of 1996. This beautiful renovation of the Music Library includes along its interior walls a new piece by Institute Professor John Harbison.

In the summer of 1997 we will begin renovation of classrooms in the main complex. We shall begin with ten classrooms in Building 2. Two of these classrooms will eventually have built-in computers at each desk, initially for the use of students in the Linear Algebra subject, 18.06.

A major renovation has begun of Building 11 to permit most of the staff in the student services area to be centrally located. This is a key part of the Institute's reengineering activities. The Information Services activities previously housed in Building 11 will move to the Graphic Arts facility on Massachusetts Avenue.

DIVERSIFYING FACULTY

The Institute's departments have continued their efforts to increase the number of women and minority faculty hires. Out of a total of 50 faculty appointments, six were made to minorities and eleven were made to women faculty, two of whom are also minorities.

Five minority faculty were appointed Martin Luther King Jr. Visiting Professors. This represented an increase of one from last year's number. Last year was the initial year of this program.

INSTITUTE-WIDE EDUCATIONAL AND RESEARCH INITIATIVES

The faculty, staff and administration of the Institute continued to foster better educational and research relationships with industry and in the international realm. This is consistent with discussions that have taken place in the Councils for Industrial Relationships and International Relationships. A new agreement was signed with Malaysia. The goal is to help develop a new private institute of science and technology which will work closely with Malaysian companies as well as educate engineers at the graduate level. Professors Berger and Lester led a study "Made by Hong Kong" that analyzed the future of Hong Kong in certain industrial areas after the takeover by the Chinese government. Discussions regarding other significant initiatives were held with groups in several other countries in Southeast Asia.

A major industrial partnership was initiated with Merck. This follows an earlier partnership with Amgen. The Merck partnership is at \$3M/yr. Discussions were held with other companies, and toward the end of the academic year a strategic partnership agreement was reached with Ford. Ford has been sponsoring research at MIT at the level of approximately \$2M/yr. This is expected to grow to at least \$4M/yr with increased emphasis on environmental and design issues.

The National Science Foundation announced that MIT will receive a new Engineering Research Center on product design, to be headed by Warren Seering. This Center will be a collaboration of faculty in the Sloan School as well as Engineering. MIT thus will be one of only a few institutions to have more than one such center. The first such center at MIT is the Biotechnology Process Engineering Center, headed by Danny Wang for the past decade.

The Lean Aircraft Initiative (LAI), located in the Center for Technology, Policy and Industrial Development, has spun off a related study, called Lean Sustainment. Whereas LAI emphasizes cost reduction in the military aerospace industry, Lean Sustainment emphasizes cost reduction during the life cycle of aerospace vehicles. Other lean-based programs, such as for satellites and ships, are under discussion.

Funding for environmental research has grown in part as a result of efforts led by the Council for the Environment chaired by the Provost and co-chaired by Professor David Marks. The Alliance for Global Sustainability held its annual meeting at MIT in January, 1997. A \$10M gift to AGS by Stephan Schmidheiny was announced. Mr. and Mrs. Lee Martin pledged \$8M toward endowing a number of Sustainability Fellows. As part of the Ford agreement, there will be over \$1M/yr. of funding for a new consortium on the environment and related environmental initiatives.

The Council for Educational Technology has drafted a major report calling for a significant new project to follow the Athena Project at MIT. It is expected that details for the architecture for a new MIT Information Initiative will be developed in the coming year.

The first class of 35 students in the Systems Design and Management program arrived on campus in January, 1997. Most of the students in this program will take it largely via distance learning. The SDM program is a Masters level program, parallel to the Leaders for Manufacturing Program and offered jointly by the Sloan School of management and the School of Engineering.

Dr. Oscar Arias Sanchez, former President of Costa Rica, and winner of the Nobel Peace Prize, gave the Karl Taylor Compton lectures during the year.

Joel Moses

CENTER FOR ADVANCED EDUCATIONAL SERVICES

Technology-enabled education is the new focus of the Center for Advanced Educational Services (CAES). We complement that focus with our continuing commitment to professional and life-long learning, as illustrated by our Advanced Study Program (ASP) and Professional Institute (PI) programs. Our educational services are distributed to

a broad spectrum of learners, studying in a variety of domains, employing established and emerging pedagogies—delivered by a combination of technology delivery mechanisms—to university students both on and beyond the Cambridge campus and lifelong learners working in industry. Again this year, the students for our courses and programs are broadly distributed, by age, geographical location and educational interest. We complement and support our educational services with a highly distinguished and recognized research laboratory, the Center for Educational Computing Initiatives (CECI).

In order to carry out its new mandate, CAES has continued to build a considerable set of assets from within MIT. CAES has assembled under its "umbrella" strategic units which harness the talents of faculty and staff in technology-enabled education and learning. These units include most notably the Center for Educational Computing Initiatives (CECI), the Advanced Study Program (ASP), the Professional Institute (PI), MIT Video Productions (MVP), and our most recent addition—the Hypermedia Teaching Facility (HTF). We believe that this collection of mutually supporting assets for technology-enabled education firmly places MIT in a position of strength going forward in this ever growing domain. We have also established close internal working relationships with relevant components of Information Systems including Academic Computing and MIT Cable, as well as academic ties to the Registrar's Office, the Deans of each the five schools, and interested faculty members, to ensure collaboration and reduce duplication of effort.

The CAES mission has been informed by the reports of three Institute-wide initiatives. These high-level MIT committees have focused on technology-enhanced education and how it should affect the MIT learning experience, both on and off campus.

- The first was the "EVAT" Committee, "Education Via Advanced Technologies," chaired by Professor Paul Penfield. Its final report is a WWW multimedia document located at URL : <http://www-evat.mit.edu/report/>
- The second was a "Large Scale Systems Committee" that gave rise to the SDM Development Committee, SDM representing Systems Design and Management; this led to MIT's first ever degree program having learners located at a distance from the physical campus during most the program.
- The third is the Provost-appointed MIT Council of Educational Technology ("EDTECH") whose current draft report is available at URL: <http://alberti.mit.edu/edtech/>

It is likely that the recommendations of EDTECH will be to devote "an effort comparable to Project Athena" toward technology-enabled education at MIT, both for on-campus and off-campus learners. We expect our evolving mission to be consistent with these recommendations. We stand prepared to assist in the development of both the physical and intellectual infrastructure required to build MIT's distance learning capabilities to world class standards. For those who wish to read more about this subject, see "Education Via Advanced Technologies," *IEEE Transactions on Education*, (39) 3, August, 1996, pp. 436-443 (related article published in *OR/MS Today*).

HIGHLIGHTS

Several key milestones have been achieved in our second year of operation, specifically:

- the physical move of our research arm— CECI— into Building 9
- the approval to renovate our existing lecture hall into three world class technology-enabled learning spaces
- an increasing number of CAES-affiliated faculty (20 at present)
- alliance and technology support of the Systems Design and Management program
- building strategic alliances with technology providers and philanthropic organizations
- the move to "production status" of synchronous-delivery MIT courses to South America
- synergy with key corporate sponsors
- addition and integration of the Hypermedia Teaching Facility (HTF) with CAES

These efforts are described below.

Center for Educational Computing Initiatives

While CECI retains its overall mission to remain a preeminent research organization in the area of application of technologies to education, CECI professionals have been working to find synergy between its traditional research initiatives and the goals of the other CAES units. We viewed the geographical separation of CECI from the other

groups in CAES as a major barrier to achieving a tighter integration of activities and staffs. Renovation of the third floor of Building 9 and the move of CECI into that space has finally brought the groups together. We have also integrated the computer operations functions of the two groups in an effort to apply CECI's more extensive expertise in this area to support CAES's ongoing work.

9-150: A Technology-Enabled Learning Center

Conceptual design and initial schematics were completed, and funding secured, to dramatically transform the 35 year old lecture hall, "9-150," into a state-of-the-art technology-enabled learning center. Demolition and construction will begin in September, 1997. The new facility will benefit several important constituencies: our on-campus faculty and students and our growing numbers of off-campus learners. The recommendations herein build from the EDTECH final report and have the approval of the Dean for Undergraduate Education and the Dean of the School of Architecture and Planning (who also serves as the senior Co-chair of the EDTECH Council).

The plan proposes to create—from a 172 seat traditional auditorium—in the cubic footage and "air space" of 9-150 three integrated and mutually supporting learning facilities:

A 45 seat tiered amphitheater in the lower level, technology-equipped for integrated on campus and off campus teaching and learning. The SDM program will be its anchor tenant with six courses scheduled for February, 1998 and synchronous delivery of programs to our strategic corporate and educational partners in Venezuela, Argentina, Peru, and Chile (February, 1998 completion).

On the upper level, an 800 sq. ft. technology-equipped room, hereafter called the "Stephen P. Kaufman Teaching Studio." Funds have been graciously committed by Stephen Kaufman EC '63 in support of this space. This facility is primarily for helping our faculty and teaching assistants to become better teachers in the full range of traditional teaching pedagogies and technological environments, from "chalk and talk" to web-based hypermedia courseware; it is secondarily to be used (on an as available basis) for distance learning (February, 1998 completion).

Also on the upper level, an 800 sq. ft. re-configurable classroom with each student location being computer-equipped, designed as a flexible learning studio that is conducive to goal oriented learning primarily in the area of engineering design. This studio will also be equipped with technologies supporting distance learning (later completion).

Technology Partnerships

Time zone differentials, idiosyncratic telecommunication monopolies/privatization policies, and the varied deployment of information technology throughout the world have provided *both* anticipated and unanticipated results in the demand for MIT "virtual" educational content. Matching technical capability and specific dedicated systems on both the delivery and receiving sides has been complex and critical to our success rate this year. Anecdotally, we noted an anticipated interest from Industrial Liaison Program companies and Pacific Rim corporations in establishing two-way interactivity; we were unexpectedly surprised and pleased by the level of interest shown by universities and technology partners in Latin America. Distribution agreements have been signed with partners in Brazil, Argentina, Chile, and Peru to deliver live content over satellite and compressed video signals. Our strategic partnership with PictureTel Corporation was a favorable factor in providing technology, bridging services, and trouble shooting solutions to these countries. Clearly, time zone incompatibilities elsewhere in the world present different opportunities and constraints and will guide and inform us going forward.

Since December 1996, CAES has been distributing pre-recorded and live small scale programs via the PBS Business Channel (TBC) LLC. This distribution relationship is a new venture for CAES, and the parameters of the relationship are still being defined. 1996 -1997 program titles included: "Challenges Facing Business Corporations", Professor Arnoldo Hax ; "The Future of Capitalism" Professor Lester Thurow; "Bits of Life -The Digital Renaissance" Professor Michael Hawley; a four-part seminar series from the MIT-Japan/China Program, and a live teleconference featuring Professor Peter Senge. A new half hour production funded by PBS, "Big M Manufacturing," focused on the Leaders for Manufacturing program at MIT. Producers at CAES and TBC are presently compiling the programming schedule for the 1997-1998 season. CAES will become a critical provider of content as the programming hours (via these methods and driven to the desk top) during fourth quarter 1997 and first quarter 1998 when TBC increases its programming by a factor of four.

Philanthropic Alliances and Corporate Sponsors

Proposals to the Lord Foundation, NYNEX Foundation, Atlantic Philanthropic, and Sloan Foundation were prepared in support of small scale experiments, for instance, planning, delivery and evaluation of five MIT subjects collaboratively offered from five schools using five delivery technologies, alternative pedagogies and five different types of learners.

CAES is grateful to its current sponsors including IBM, Turner Broadcasting, PictureTel, ADCOM Communications, and Lotus Institute for its generous support during the current year.

Synchronous Delivery of MIT

The Advanced Study Program Strategic relationships have been signed with various educational organizations and corporations including the Universidad Gabriela Mistral in Santiago, Chile and San Ignacio de Loyola in Lima Peru, and YPF in Argentina and Venezuela. Compressed video technology has been used to deliver credit bearing courses including: 13.716 Management of Technological Change and 13.61 Project Management (Professor Ernst Frankel), 15.820 Advanced Marketing Management (Professor William Qualls) and 15.968 Economic Concepts for Engineers and Managers (Professor Shlomo Maital).

MIT Video

MIT Video Productions provides analog and digital equipment, facilities, and expertise to members of the Institute community involved in the creative, scholarly, promotional and research applications of video. Highlights of last year's activities include the video documentary of the Research Lab for Electronics' 50th anniversary exhibit. Working in partnership with the Dean's Office in the School of Engineering, and with support from the President's Office, production of a historical series featuring recent faculty retiree's is progressing. MVP became increasingly involved in the public relation's mission of the Institute. Working closely with the President's Office and the News Office, MVP produced a fast paced overview of the Institute titled "MIT: Mind and Hand". MVP also continues to work with the News Office in the production of video materials for distribution to electronic media outlets.

HONORS AND AWARDS

Scott Dynes, Lestra Litchfield, Ana Beatriz Chiquito jointly received an award for the best paper entitled, "The case for database support in multi/hypermedia application development and use", presented at the *1997 World Conference on Educational Multimedia and Hypermedia and Educational Telecommunications* meeting of the Association for the Advancement of Computing in Education, held in Calgary, Canada.

PROGRAM HIGHLIGHTS

Technology Support of Systems Design Management (SDM)

Beginning in Spring, 1996, CAES provided initial housing for the SDM program and MVP provided compressed video hardware and staff effort to enable delivery of its certificate and degree distance learning offerings to a dozen remote sites in the US and Canada. The shift in teaching style and presentation materials necessary to deliver course material over these modalities has evolved and more efficient and more robust facilities have been developed to ensure uninterrupted audio and visual signals and redundancy. Since the faculty teaching in the program are forerunners in this area, lessons learned from their experience have been a guiding force in the development of our new facilities described above.

Professors Tom Magnanti and John Williams are enthusiastic about the new learning facilities and have expressed interest in working with CAES for non-credit course offerings which we can offer to ASP fellows.

Strategic Marketing

Marketing activities cross boundaries for all five CAES strategic business units, and encompass activities and projects across the Institute. Since last year's report, we developed a marketing strategy, communications plan, and prepared promotional materials, brochures and graphical images about our new activities. The number and frequency of individuals/corporations requesting information, information sessions, facility tours, and meetings grew exponentially. We now view relationship building (rather than transactional based marketing and sales) a key to our activities in this area.

In the Fall of 1996 CAES co-sponsored with the Industrial Liaison Program MIT's first distance education conference, entitled, "Distance Learning: The Strategic Revolution in Professional Development & Employee Education" and trade show. Designed for human resource professionals, managers, and training professionals, the conference was attended by 250 people locally as well as four sites via video conferencing. The two day event featured talks and sessions by colleagues in distance learning including the American Association for Higher Education, Andersen Consulting, the Stanford Center for Professional Development, and the Instituto Tecnológico de Estudios Superiores de Monterrey (Mexico), PictureTel Corporation, and the National Technological University. The second day included a "trade show" where participants could get detailed information and/or demonstrations of distance learning programs and technology.

The Infinite Corridor series was renewed last year. ILP and CAES co-produced a four series set of programs for ILP affiliated companies. CAES affiliated faculty featured in this series include Professor Hax, Professor Michael Dertouzos, Professor Paul Krugman and the "50K competition."

Advanced Study Program

ASP experienced a growth in half-time and full-time on-campus fellows for both academic terms, while the number of quarter time fellows—those enrolled in only one credit bearing subject—grew even faster. During the Fall of 1996 48 students representing 10 countries (Argentina, Brazil, France, Japan, Korea, Ivory Coast, Spain, Taiwan, USA and Venezuela) and 33 diverse industries and government departments enrolled as fellows.

During the spring of 1997 we enrolled 52 students representing 12 countries (Argentina, Belgium, Brazil, France, Italy, Ivory Coast, Japan, Korea, Spain, Taiwan, USA and Venezuela) and 34 diverse industries and government departments. The enrollment was up by approximately 30% relative to the Spring of '96.

United States citizens represented the highest percentage of our student population, on a per country basis.

General Motors NAO Validation Center and Cadillac/Luxury Car Engineering & Manufacturing Division in the USA along with Delphi in Luxembourg received a course on Modeling and Simulation of Dynamic Systems by Professor Neville Hogan by videotape. The faculty-student interaction throughout the course was conducted by electronic mail. The students gave a high rating to the course. In the spring of '97, a select number of managers from Lagoven, oil company in Venezuela, received a short course by video conference on Dynamic Strategic Planning by Professor Richard deNeufville.

Professional Institute

The activities of the Professional Institute remained stable and remarkably unchanged from the previous years as illustrated in the following table:

Registration comparison

| | | | |
|-------------|--------------------|-------------|---------------------|
| Summer 1994 | 1252 registrations | 51 programs | by 1199 registrants |
| Summer 1995 | 1274 registrations | 53 programs | by 1222 registrants |
| Summer 1996 | 1242 registrations | 55 programs | by 1242 registrants |

Hypermedia Teaching Facility

The Hypermedia Teaching Facility delivers quality hypermedia curriculum via the Internet. Initial efforts have been in Mechanical Engineering and as of July 1, 1997 the facility is now housed in Building 9 and reports to CAES. The "curricular hyperweb" is remotely accessible to current and continuing (alumni/alumnae) students as well as industrial partners at large. Our digital non-linear editing system allows us to compress video files for delivery on the Web in quick time format, yet has the capability of mastering programs for broadcast. During the last year, two hypercourses were developed as pilot projects to create a systematic methodology for re purposing video courses developed by CAES. The first pilot was based on the Machine Shop videos made by Dr. Erik Vaaler and partially supported by Instructional Systems Inc. This course is currently being beta tested. The other course runs in parallel with a live economics course delivered to multi-points in South America. Courses in the hypermedia curriculum include: 2.001—Mechanics and Materials, 2.006—Thermal Fluids Engineering II, 2.25—Advanced Fluid Mechanics, 2.40—Thermodynamics, 2.70 module on Machining, 2.672—Project Laboratory, 2.792—Quantitative Physiology, 2.993—Special Topics in Mechanical Engineering, and 15.968—Economic Concepts for Engineers and Managers.

Research Achievements

This is the final year of the large, DARPA/NSF-funded project in networked delivery of multimedia information. The project, originally based at CAES and directed by Professor Shaoul Ezekiel, is now jointly managed by CAES and CECI, with Professors Richard Larson and Steve Lerman serving as co-Principal Investigators. In this final year, we have continued improving the technology that was developed to offer an Internet CNN Newsroom, and an Internet-based delivery of news prepared in standard, analog form by Turner Broadcasting.

Extending our capabilities in computing in the humanities, CECI is now providing the technological support to Professor Peter Donaldson's Shakespeare Project, and Dr. Janet Murray has been working with Professor Henry Jenkins in Film Studies on a NEA-funded program to use multimedia to teach in this area.

This was the second year of involvement in the Army Research Laboratory's Federated Laboratory program. Professor Lerman represents MIT in a coalition of other universities and corporations including Lockheed-Martin, Motorola, GTE and Bellcore. Our component of this group's large, multi-faceted research program focuses on issues of Internet delivery of information in highly heterogeneous networks, including work on caching algorithms.

CECI is currently funded by Continental Cablevision (now called MediaOne) to explore how low cost, high speed Internet connections that they are delivering via cable modems to residential customers can be used to create new services, including educational offerings, that were previously not feasible due to bandwidth limitations.

The collaboration with the University of Bergen in Norway and EAFIT University in Colombia continues to develop interactive, multimedia software to teach Spanish. This work builds on the extensive experience MIT gained during Project Athena. However, Operacion Futuro is developing a full, second year curriculum rather than a small module within a single course. A major publisher has recently tested the prototype software developed by CECI and is now negotiating to publish Operacion Futuro.

CECI has been working with Professor Dennis McLaughlin of the Department of Civil and Environmental Engineering to develop a simulator for ground water contamination cleanup. This work builds on a project Professor McLaughlin started during Project Athena. Work has included extending the simulation algorithms, redoing the user interface and migrating the entire software system to Microsoft Windows platforms.

Working with Professor Peter Perdue of the History Section and the Long Bow video production company, CECI has developed a full prototype of a digital archive of film, video, audio, images and text about post-WWII China. This prototype was written in the AthenaMuse 2 authoring system developed by CECI. It has been presented to approximately 18 foundations for major funding, which if granted, will lead to the complete implementation of the archive, including digitizing over 300 hours of video from Long Bow's archives.

CECI has been working on a research project funded by Houghton-Mifflin Company. This project is developing a series of software object classes to represent complex documents and the information to manage educational delivery of those documents. These are being prototyped in the Java programming language and tested on materials supplied by Houghton-Mifflin.

PERSONNEL

Dr. Janet Murray, the former Director of the Laboratory for Advanced Technology in the Humanities, joined the CECI staff this year. She brings her extensive experience in directing computer-based learning projects in the humanities. She recently published *Hamlet on the Holodeck: The Future of Narrative in Cyberspace* (Free Press, Simon and Schuster, 1997). Dr. Nishikant Sonwalker, the Director of the Hypermedia Teaching Facility, joined the CAES development staff in the latter part of the year. He brings extensive experience in hardware/software systems in providing a crucial wrap around web-environment for our educational offerings.

FUTURE PLANS

The assets of CAES include the full range of services and activities needed for MIT to begin to assume a preeminent position in technology-enabled learning, both on and off campus. Building from our new base of relative strength, here is a summary of future plans—both short term and longer term:

-
- On the technology front, our new “9-150” learning facilities will come on line next year. This will require extensive interaction and cooperation with key MIT participants of each of the three learning spaces within the renovated facility.
 - The integration of the ATM network will be accomplished by linking the switch to key parts of CAES, including the video production studio and the new learning facilities.
 - We plan to work closely with the SDM program in helping to create and implement a web-based environment to assist in the asynchronous delivery of SDM courses world-wide. We hope to acquire corporate co-sponsorship in creating the web learning environment, with the intention of MIT co-development of a world-class software package for commercial distribution and support. If we can arrange it properly, this environment can also be used by all MIT faculty for placing their courses on the web in a rich multimedia learning environment.
 - We plan to expand our distance learning courses and programs to Latin America, focusing our efforts on corporate partners there. We hope to start to offer distance learning programs to Asia, building from a total of five trips to Asia taken in 1997 by Professors Larson and Lerman.
 - This year our hope is that the MIT administration will choose to implement the major recommendations of the EDTECH Council and that CAES may play a leadership role in the many educational experiments to be carried out.
 - Via anticipated foundation funding, we hope to hire a nationally recognized scholar in the evaluation of technology-enabled education and learning. The lack of such a person at CAES (and at MIT) is a weakness in our current asset base. With such a person, CAES can assume a leadership role in the evaluation of experiments involving technology-enabled education. It is envisaged that these experiments will be defined both internally from within CAES and by others at MIT as part of the EDTECH experimentation.
 - A formal CAES “affiliated faculty” committee will be assembled in the fall of 1997.
 - The strategic relationship that CAES has with The Business Channel (TBC) will be enhanced and deepened in 1997-8. This relationship may grow to include—in addition to content creation—engineering support services to assist in the final design and operation of TBC’s “fibre-to-the-desktop” learning.
 - We plan to grow and extend the strategic relationships we have with CAES corporate partners.
 - By acquiring funding for the “Long Bow China Archive Project,” CECI hopes to become a major contributor to the evolution and functionality of multimedia archived libraries. The interest in this project is intense, in the U.S. and throughout Asia.
 - We will continue to invest in core activities such as ASP, PI, and MIT Video, to assure that our key strengths here are not diluted in any way.
 - CECI will be working with the Black Alumni/ae Association of MIT to develop a digital, multimedia archive of the accomplishments of African-Americans in science and technology. This work continues our emphasis on the creation and operation of large scale, digital, multimedia archives. The Networked Multimedia Information Services Project, the Long Bow China Film Archive, the Edgerton Image Collection, and our technical support of the Shakespeare and Film Studies Projects in the School of Humanities all share this common characteristic.
 - CECI is shifting most of its software development to the Java Programming Language developed by Sun Microsystems. A recently launched project to create a world wide database of Java classes and Java Beans will be based at CECI.
 - CECI will continue its long tradition of working in language education begun by CECI staff such as Janet Murray during Project Athena. Work on Operacion Futuro and No Recuerdo (two Spanish language projects) will finish in this academic year. A proposal has been submitted to UNESCO to create an Internet forum for technology-enabled language learning, and discussions are underway with the School of Humanities faculty in the area of English as a Second Language.
 - CECI will be increasingly involved in MIT's international programs. Proposals have been submitted under the Technology Development Program for research in both Thailand and Malaysia.

More information about this Center can be found on the World Wide Web at the following URL: <http://www-caes.mit.edu/>

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). Considerable progress was made in the development of a curriculum for the establishment of a new, undergraduate major in Archaeology and Materials, approved by DMSE faculty as Course III-C. The faculty also approved the establishment of an interdisciplinary doctoral degree program in Archaeological Materials. Both sets of curricula will be reviewed by the appropriate MIT committees during the 1997-1998 academic year with the expectation that they will be in place by the fall 1998 semester.

Archaeological Science, the CMRAE/CAM undergraduate subject introduced during the 1995-1996 academic year, was offered jointly for the first time by DMSE and the Chemistry Department. It continues to enjoy high popularity among students from CMRAE institutions. Seventy-five students enrolled: 54 from MIT, nine from Brandeis University, seven from Harvard University, three from the University of Massachusetts, and two from Wellesley College; 13 faculty members from five CMRAE institutions lectured in the subject. Professor Heather Lechtman taught the year-long CMRAE graduate subject, *Materials in Ancient Societies: Metals*, to eight students from four CMRAE universities. Noteworthy among their laboratory findings was the discovery of the earliest brass (Cu-Zn) alloy artifacts known in prehistory, from the site of Nuzi in ancient Persia. The Nuzi artifacts were lent to the class for study by Harvard University's Semitic Museum.

The outstanding event for CAM was the award to tenure to Professor Dorothy Hosler. Her remarkable book, *The Sounds and Colors of Power*, confirms the intellectual strength of the center's perspectives and provides continuity to CAM's long-standing leadership in the field of the materials science of material culture. Professor Hosler continued her archaeological/geological field research in west and central Mexico to determine the metallic ore mining, processing, and extractive metallurgy technologies carried out in ancient Mesoamerica. She began a new field investigation with a UROP student in Chiapas, Mexico. They are investigating the manufacture of rubber by ancient Mexican peoples for use in the widespread and ritual Mesoamerican ball game. Professor Lechtman received a grant from the Brennan Foundation which supported a three-month period of geological fieldwork in Chile and Bolivia for the purpose of locating and sampling ores containing arsenic and/or nickel. Such ores may have served as sources for the rare, ternary copper-arsenic-nickel alloys she has found in artifacts from the region that date to the Middle Horizon (roughly A.D. 600-900).

CAM was enriched by the research of three post-doctoral associates. Their work included the laboratory investigation of copper fasteners from the USS Constitution and from other period British ships; analysis of an unusual cloisonné inlay technology used on ceramic vessels from north and west Mexico; and the electron microscopy of metal, matte, and slag materials produced during the experimental co-smelting of copper oxide and copper sulfarsenide ores.

In addition to realizing the establishment of undergraduate and graduate degree-granting programs, CAM/CMRAE expects to respond to a new initiative undertaken by the National Science Foundation. The aim of the Foundation's Integrative Graduate Education and Research Training Program (IGERT) is to prepare doctoral candidates

with multidisciplinary backgrounds and the technical, professional, and personal skills essential to addressing the varied career demands of the future ... [through] ... development of innovative, research-based, graduate education and training activities that will produce a diverse group of new scientists and engineers well-prepared for a broad spectrum of career opportunities.

CMRAE has been educating graduate students in science, engineering, social science, and the humanities since the center's establishment in 1977. We are eager to enter the new NSF competition and to bring our deep fund of experience to bear on the education of scholars broadly and in depth.

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. There are four main programs sponsored by the Council: The Institute for Learning and Teaching; the MIT/Wellesley Teacher Certification Program; the Forum on Public Education; 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 New England Science Teachers and a collaboration with the Association of American Universities.

PROFESSIONAL GROWTH OF EDUCATORS

TILT provides professional development for educators that uses a project centered around a common technology, such as water delivery systems, as a vehicle for developing skills in team building, group dynamics, effective communication, negotiation, grant writing, brainstorming, mind mapping, working with different learning styles, group reflection and debriefing, and computer use. The traditional TILT model is a community-based team of teachers, school administrators, and their champions in the community (parents, school board members, university representatives, or industrialists) that spends three-weeks in July in residence on MIT's campus followed by a year of planning how to implement and integrate TILT ideas back in the team's home community.

In 1996, TILT's summer residential component ran from July 8-26 and teams attending came from Ashtabula County, OH; the ECSEL Program; and Boston Public Schools. Each year, TILT chooses different technologies to investigate, in the past looking at water treatment and delivery, construction, mass transportation, telecommunications power generation, and health care. In 1996 teams explored either MIT's cogeneration power plant, the MIT identification card system, or automatic teller machines. Each team was linked to a site (a facility or business engaged in the technology) and explored in detail one technical aspect of the technology, determining who it serves and how it serves them. Teams examined how the sciences, mathematics, and the social sciences intertwine to produce the technology, how it might be changing, and how it compares with trends in education. All teams returned to their communities in August with the charge to share their experiences with colleagues in their home community and to promote school improvement. To help them maintain communication with TILT, MIT, and other community groups, each team was given seed money and was loaned a laptop computer with a subscription to America Online for one year.

TILT'96 was funded by the Alden Trust, Ashtabula County Schools, the Bey and Phyllis Blanchard Fund, James A. Daley Fund, Harcourt-General Charitable Foundation, Massachusetts Department of Education Goals 2000 Grant, National Science Foundation's Engineering Coalition of Schools for Excellence in Education and Leadership. In addition, TILT'96 received funds or support from MIT's Office of the Provost and MIT libraries. Support for the UROP students was provided by the MIT Class of 1992.

TILT will look a little different in 1997; it has joined with the Whittier Institute for Learning and Teaching (WILT), a successful TILT spin-off at Whittier Regional Vocational School in Haverhill, MA. Teams from Ashtabula, OH; the ECSEL Program; Lawrence Public Schools; and Greater Lawrence Regional Vocational High School will join two teams from Whittier itself for an eight-day institute running August 16-23 and patterned after the TILT model. Due in part to the shortened time available, the research/technical project focus has been sharpened to an in-depth study of measurement and measurement tools in a number of selected North Shore businesses.

One of TILT's long-range goals is to spin off a wide variety of TILT models and satellite operation. In addition to WILT, there are four other efforts underway:

- The TILT Design Team is currently working with the Massachusetts School-to-Work office to help each of the state's 15 community colleges develop a TILT model on its campus. TILT personnel conduct half-day institutes tailored to meet the needs of the faculty, staff, and administration on each campus.

-
- Professor Center, a TILT alumna and assistant professor at Bristol Community College (BCC), is beginning to develop a TILT spin-off on BCC's campus.
 - TILT's model of professional development has been adopted by the seven universities that make up the Coalition of Schools for Excellence in Education and Leadership (ECSEL), which is supported by the National Science Foundation (NSF).
 - The South African Ministry of Education has awarded Alan Dyson a fellowship to conduct two week-long TILT institutes in July, 1997, at the University of Natal and to spend a week talking with businesses in all the states of South Africa about forming business/university/public school partnerships to enhance educational opportunities.

An impact study funded by the Noyce Foundation began in 1996. The study will focus on eight TILT teams in Massachusetts and will determine the impact of TILT on individuals, teams, school systems, curriculum, and students. Preliminary reports will be made to the Noyce Foundation program officer in fall of 1997, with a final report due in late spring of 1998.

TILT's staff was severely reduced over the past year. Alan Dyson, one of TILT's founding members, accepted early retirement from MIT in 1996. While he is no longer on the MIT payroll, he continues to consult actively with TILT and remains the liaison between TILT and the Ashtabula County, OH, teams. TILT also lost Christopher Craig, another founding member. He, like Mr. Dyson, continues to consult for TILT, and is the liaison for the Harlem Choir Academy in New York City. Due to a shortage of funds, TILT was forced to lay off both Kelley Fisher, TILT's secretary, and Linda Breisch, TILT Design Team member and communications manager.

More information about TILT can be found on the World Wide Web at the following URL:
<http://web.mit.edu/tilt/www/>.

MIT/WELLESLEY TEACHER CERTIFICATION 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, and eight students in the program completed the certification process in 1997.

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.

TEP is currently funded by the National Science Foundation through a collaborative called TEAMS-BC (Teacher Education Addressing Math and Science in Boston and Cambridge), which consists of MIT, Harvard, UMASS Boston, Wheelock College, and the Boston and Cambridge school systems. NSF has awarded TEAMS-BC a grant of \$5,000,000 over five years. TEP is supervised by Professor Jeanne Bamberger.

The Noyce Prize, a \$10,000 prize provided by the Noyce Foundation, is awarded each year to an outstanding graduating senior who has chosen a career in teaching and who has completed (or will complete) certification requirements to teach math or science in a public school. This June, the award was given to Tim Piwowar, a graduating senior in mathematics. The first recipient of the prize, Sally Buta (Course 3, 1994) is now teaching physics at Cambridge Rindge and Latin High School, in Cambridge, MA. The second recipient, Ricardo J. Campbell (Course 10, 1995), is teaching 8th grade science at the Longfellow School in Cambridge, MA. Last year's recipient, Catherine Lavelle (Course 18, 1996) is teaching mathematics in the Lincoln Middle School in Lincoln, MA.

More information about TEP can be found on the World Wide Web at the following URL:
<http://web.mit.edu/teacher-ed/www/>

FORUM ON PUBLIC EDUCATION

CPSE continued its series of seminars, the Forum on Public Education. Thomas Payzant, Superintendent of Boston Public Schools, participated in a panel discussion entitled "Focus on Children" on December 9, 1996. John Silber, Chairman of the Massachusetts Board of Education, delivered a seminar on "Education in Massachusetts and the Nation: Problems and Opportunities" on February 12. A seminar by Frank Levy based on his new book *Teaching the New Basic Skills* was postponed due to inclement weather. It has been tentatively rescheduled for early September. The Forum on Public Education is sponsored jointly by MIT's Council on Primary and Secondary Education and the Boston Museum of Science. The purpose of the seminar series is to foster conversation between leaders in the educational reform movement and the public at-large.

EDUCATIONAL OUTREACH DIRECTORY

Early this spring, the Council published a new edition of *MIT's Educational Outreach Programs*. 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 on the World Wide Web.

UPDATE ON JOINT VENTURE WITH SCIENCEMEDIA, INC.

ScienceMedia, Inc., is a toy company created by MIT alumna Joan Roth that promotes science literacy through toys and TV, the goal being to attract children usually turned off by science. The company produces science kits that contain all necessary equipment for an experiment, full instructions, and science trading cards. The first product line focused on Better Sports Through Science, and is in its second production run. A new product line focusing on earth science is in development. MIT's name and logo appear on the kit box, and royalties from sales are shared with CPSE.

PROGRAMS BY THE CPSE CHAIRMAN

For the past year, Professor Latanision, Chairman of CPSE, has been on sabbatical, working with the American Academy of Arts and Science in Cambridge, MA, to implement suggestions made in last year's white paper *Role Of Universities In K-12 Education*. He was instrumental in developing a proposal, referred to as the College Presidents' Initiative, that was submitted to the Association of American Universities (AAU) early this year. The presidents of six major universities—Robert Berdahl of the University of Texas-Austin, Gerhard Casper of Stanford, Charles Vest of MIT, Lee Bollinger of the University of Michigan, Neil Rudenstine of Harvard, and David Ward of the University of Wisconsin-Madison—propose connecting AAU planning efforts now underway with the National Research Council and the Academy to act collectively in the areas of college admissions policy, teacher preparation, and response to the effects of K-12 educational reform on basic undergraduate curriculum.

During this past year, Professor Latanision has also worked with the federal School-to-Work (STW) Office to bring it together with the business community and business schools around the theme of work-based learning. On June 16, 1997, Professor Latanision, Professor Robert Schwartz of Harvard University, and Dr. Howard Hiatt of Brigham & Women's Hospital hosted a roundtable discussion between business leaders and research university faculty in Massachusetts. Discussion centered around the expectations and realities of industrial involvement in work-based learning. This topic will be taken up as well at the national meeting of the National Research Council in September.

Professor Latanision directs the Science and Engineering Program for Middle and High School 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 1997, the program ran from June 23-28 and had 50 participants from across the United States.

The alumni of this program, now totaling approximately 500, become members of the New England Science Teachers (NEST). This year, NEST members came to MIT's campus on June 27th for a two-day meeting to assess the program and determine future directions for the organization. NEST will be supported by a grant from Raytheon through 1998.

More information about NEST can be found on the World Wide Web at the following URL:
<http://web.mit.edu/nest/www/>

NEST members are in the initial planning stages of a new project, Scientists Online (SOL), that will link NEST teachers and their students who are studying topics in science, mathematics, and technology with MIT faculty volunteers who have expertise in that area. Descriptions of faculty expertise and availability will be listed on the NEST home page, and online facilitators will coordinate and monitor the interactions between the K-12 classrooms and the MIT faculty.

In August, Professor Latanision will be relinquishing his role as a co-principal investigator for the NSF-supported statewide systemic initiative in Massachusetts, PALMS (Partnerships Advancing the Learning of Mathematics and Science). PALMS reaches the end of its Phase I in August, and will be embarking on a slightly new direction in its Phase 2.

Over the past year, Linda Breisch, Communications Manager for CPSE, has also assisted PALMS by acting as a regional coordinator for the central part of Massachusetts. PALMS Phase 2 no longer requires this role, so Ms. Breisch will be leaving the PALMS project at the end of June, 1997.

More information about the Council can be found on the World Wide Web at the following URL: <http://web.mit.edu/cpse/www/>

R. M. Latanision

FACILITIES USE COMMITTEE

Reporting to the Provost, the Facilities Use Committee formulates and implements policy for the use of Institute facilities by recognized MIT groups, guests from off-campus, and by non-MIT organizations hosted by Faculty and recognized campus groups.

Chaired by Stephen Immerman, Director of Administration and Operations, Office of the Dean of Students and Undergraduate Education, this year's committee membership included Margaret Bates, Dean for Student Life, Office of the Dean of Students and Undergraduate Education; Mary Callahan, Assistant Registrar, Schedules; Gayle Fitzgerald, Director Conference Services, Events and Information Center, Public Relations Services; Michael Foley, Associate Director of Operations, Campus Activities Complex; Elizabeth Garvin, Director, Class Programs, Alumni Association; Anne Glavin, Chief, Campus Police; Margaret Jablonski, Associate Dean, and Section Head, Residence and Campus Activities; Edmund Jones, Administrative Assistant, Music and Theater Arts; Sandra Lett, Administrative Assistant, Facilities and Scheduling, Athletics; Dan Martin, Assistant Department Head for Facilities and Operations, Athletics; Paul Parravano, Assistant for Community Relations, Office of the President; Clarise Snyder, Concert Director, Music and Theater Arts; Mary Tobin, Supervisor, Operations Center, Physical Plant; Susan Tomases, Program Director, Alumni Association; Tina Trager, Event Coordinator, Campus Activities Complex; and Phil Walsh, Director, Campus Activities Complex.

The following changes in committee membership occurred this year: Nancy Cavanagh, Administrative Officer, Music and Theater Arts retired. Clarise Snyder and Edmund Jones were appointed to the Committee to fill this vacancy. Margaret Bates and Dan Martin were added to the Committee to represent their respective departments.

Re-engineering information and updates that were shared with the Committee included changes to the Event Registration Process, the introduction of local zones by Physical Plant, and the review of campus dining.

During the 1996-97 year, in addition to a number of smaller meetings, the Institute hosted the United Church Coalition, the American Computer Experience Camp, the Summer Research Conference, the graduation ceremony of Cambridge College, the City Days Festival, the 3rd International Conference on Carbon Dioxide, two Career Connection Job Fairs, the American Physical Society Conference, the New England Board of Higher Education, a conference on Artificial Intelligence, the North American Power Symposium, the Participatory Design Conference, the Massachusetts Junior Classical League Conference, a concert by the Cambridge Community Chorus, a banquet for the Cambridge Mental Health Association, St. Paul's AME Easter Service, the Yale Alumni Seminar, the Massachusetts State Science Fair, the Massachusetts Biotech Council, the Massachusetts Future Problem-Solving

Bowl, the African Methodist Episcopal Zion Church Conference, the Massachusetts Special Olympic Games, and the Wet Ice Conference.

Stephen D. Immerman

OFFICE OF EDUCATIONAL OPPORTUNITY PROGRAMS

The Office of Educational Opportunity Programs was created in January of 1992 to organizationally locate both the MIT/Wellesley Upward Bound and MIT Educational Talent Search Programs. 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 US 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 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, represent just such interventions.

It has been long established that the effects of failure can be reversed through gradual structured achievement. Moreover, the result of the increasing success is a corresponding increase in the individual's level of aspiration. The Educational Talent Search Program, now in its 6th year, is reporting increasing success. Further, the Upward Bound Program continues its lengthy record of success (90+ percent college enrollment of graduates and 70 percent retention of participants annually) achieved during its 30 year existence through the application of Kurt Lewin's theory and careful attention to the impact of Program expectations.

Finally, since much of what students think they can achieve has been directly related to what others think they can accomplish, the participants' perceptions of their abilities are, to a significant degree, determined by staff expectations. Thus, and largely due to this quasi-parenting relationship, the Programs are able to exert such an influence upon the participants that their academic persistence grows and results in increased post-secondary enrollments.

MIT EDUCATIONAL TALENT SEARCH

The MIT Educational Talent Search Program (ETS) is a year-round, co-educational, program, located in Building 20, designed to assist participants, in grades 6-12, who live and/or attend school in Cambridge and Somerville to continue in a course of education leading to graduation from secondary school and enrollment in post-secondary educational programs. The Program is funded to serve 675 participants from disadvantaged backgrounds.

The following is an overview of the Program's year-round operation:

The academic year program is designed to inform, assist and support participants during the school year through a number of after school, evening, weekend, and school holiday activities.

The ETS staff are available at our offices via appointment or on a drop-in basis, five days a week. The Program provides assistance to the two public high schools, one parochial high school and 26 elementary (K-8) schools in the target area. ETS staff are available at Cambridge Rindge & Latin School and Somerville High School, four days per week, on an alternating schedule basis, and North Cambridge Catholic High School one day per week. Target

elementary schools are served through quarterly in-school presentations, and weekend and vacation workshops and exploratory activities throughout the school year.

The Program offers workshops to supplement the instructional support provided to participants. The workshops are offered to provide more specific support or to address special interests (e.g., SAT preparation, Word Processing, Time Management, Peer Pressure, Computer Skills, etc.) and are offered on a regular and as needed basis.

In an effort to assist participants as they attempt to cope with problems of an academic, social, family or personal nature, the Program offers support and referrals in the areas of school guidance, academic and vocational preparation, and personal adjustment.

In an effort to provide both participants and their families with information relative to college choice, preparation, and the admission and financial aid processes, the Program held four parent and eleven student information nights, took participants to five local College Fairs and sponsored eighteen college visits. The Program made five career exploration tours. The sites visited were; Middlesex Juvenile Court, Cambridge & Somerville Police Headquarters, Lotus, and Cambridge City Hall, as part of its career exploration effort.

The Program provided seven field trips for the purpose of increasing the intellectual, social, and cultural development of the participants. Some of the sites visited were; Museum of Science, New England Aquarium and Butternut Basin Ski Area. In addition, the Program regularly visits several points of interest, i.e., libraries, museums and laboratories, on the MIT campus.

In conjunction with the Mayor's Summer Youth Program, 8th-10th grade participants were provided with college information through a college fair and two college tours.

The Program's follow-up survey of its members of the Class of 1996 yielded the following: 58% of all senior class members enrolled in a post-secondary educational program; 14% of these members enrolled in two-year programs; 23% enrolled in four-year public institutions; 59% enrolled in four-year private institutions; and 4% enrolled in proprietary programs or enlisted in the armed forces.

MIT/WELLESLEY UPWARD BOUND

The MIT/Wellesley Upward Bound Program is a year-round, co-educational, multi-racial, college preparatory program for high school youth who reside or attend school in Cambridge. Currently in its 30th year, the Program serves 70 academically promising young men and women from disadvantaged backgrounds. The goal of Upward Bound is twofold: (1) to motivate client high school youths such that they persist on to post-secondary education; and, at the same time, (2) 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. Upward Bound participants must enroll in three classes, each of which meets for an average of five and one-half hours per week. Also, participants may request or be assigned to tutorials whenever the need arises. Each participant is required to enroll in a Mathematics course, an English course and an elective course (Social Studies, Science or Foreign Language). Science electives include: physical science, biology, chemistry, physics and computers while Social Studies address United States, African-American and World Histories. The Foreign Language electives are Spanish I and II as well as French I and II. The Mathematics courses range from arithmetic to calculus and Language Arts courses cover basic English and grammar through research paper writing and literature. Lastly, due to an agreement with the Cambridge Public Schools, students may receive summer school credit for failed courses taken for review.

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 have been developed, staffed primarily by MIT and Wellesley College students when appropriate. 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: Monday and Thursday from 3:00 to 6:00 PM and Tuesday and Wednesday 3:00 to 8:00 PM. 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 classes, specifically for the 9th & 10th grade students, in Mathematics and Language Arts to supplement the instruction received at the target school. Also, workshops are offered monthly to address more specialized participant needs (e.g., SAT Preparation, Computers, Study Skills Development, Time Management, Job Readiness Skills, etc.).

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 and Job Site Visitation Program.

The Program provides numerous field trips which have as their purpose, the intellectual, social and cultural development of the participants. Such trips included; the Museum of Science, the Omni Theater, theatre productions, skiing, bowling, and roller-skating.

Ninety-four percent of the Program's graduating seniors have enrolled in the following institutions: Boston University, Brandeis University, Bridgewater State College, Emmanuel College, Fitchburg State College, Lasell College, Newbury College, Northeastern University, Rutgers University, Syracuse University, University of Massachusetts at Boston, Wentworth Institute of Technology, and Western New England College.

Ronald S. Crichlow, Evette M. Layne

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. In the past year the Office has focused on 5 major areas of activity. These are discussed below:

ROTC

The Associate Provost chairs the Implementation Team that President Vest established to carry out the April 1996 vote of the faculty on ROTC. Other members include: Professors William Watson and Kim VanDiver, Dean Margaret Bates, Colonel William Rutley and Ms. Sarah Gallop of the President's Office.

The faculty voted that MIT should pursue a series of actions to broaden access to a modified ROTC Program, to support students who are disenrolled from ROTC due to sexual orientation, and to continue to advocate for national change. The desire to pursue these actions was based on two important principles which informed the vote and framed the Implementation Team's work. First, MIT is committed to a policy of non-discrimination in educational and other campus programs. Second, MIT is committed to preparing students for national service and for effective leadership. ROTC has played an important role both at MIT and nationally. MIT recognizes that the leadership skills derived from the ROTC Program are valuable and believes that these benefits should be available to all interested students.

Subject to further review, the faculty voted that continued participation in ROTC was appropriate on the understanding that MIT will seek the eventual end to discriminatory policies and, within the limits of the law, develop modifications in the ROTC program that would expand the educational benefits of ROTC to all MIT students.

Based on the Faculty Resolution, the following action items frame the team's agenda. The Committee consulted with other colleges, universities, and advocacy groups to explore opportunities for joint action and legal advocacy to further the goals of the faculty vote. The team will identify and support activities that improve the climate for gay and lesbian members of the community, and we will open a dialogue on issues related to gays in the military. There has been no significant activity within the past year at any of MIT's peer institutions which host ROTC on their campuses. Some schools that MIT has worked closely with on this matter have indicated that they are waiting to see what actions MIT will take before they move forward. Two schools in the California State system—Sacramento and San Jose—have reversed their positions on ROTC and have reinstated the programs on campus.

There are other cases at the federal circuit level as well as in lower courts, (including three in California's 9th Circuit Court of Appeals,) which are considered by advocacy groups believe to be most likely to deliver an unconstitutional ruling regarding the federal law in 1997. If so, this could mean that the Supreme Court might agree to hear the first "Don't Ask, Don't Tell, Don't Pursue" case in 1997. We will continue to monitor the cases, consult with counsel, and recommend action as appropriate.

Since April 1996, there has been little visible activity in Congress regarding the "Don't Ask, Don't Tell, Don't Pursue" law and the general matter of participation of homosexuals in the military. However, there were two legislative actions that have some significance for our work. The first was a broadening of the Solomon Amendment, which had originally stipulated that DOD funding would not be granted to institutions that prohibited military recruiting or prevented the maintenance or establishment of an ROTC operation. The second legislative action was a tightening of the participation restrictions in ROTC programs. The *National Defense Authorization Act of 1997* now stipulates that only students who are eligible for advanced military training may participate in field training or practice cruises.

The Committee on Undergraduate Admissions and Financial Aid created a reinsurance policy that provides administrative support and financial resources to students who are involuntarily disenrolled from ROTC because of sexual orientation. The April 1996 MIT faculty vote included the following item dealing specifically with financial support for students who are disenrolled from ROTC because of sexual-orientation.

"MIT will reinsure MIT students who lose ROTC scholarships due to their sexual orientation with a financial-aid package consisting of the standard need-based MIT scholarship, plus an optional supplement contingent upon public service."

The objective of this element was "... to counteract, to the extent we can, the on-campus consequences of current discriminatory policies against homosexuals in the US military by reinsuring the DOD scholarships of disenrolled homosexuals."

In its final report to the faculty the ROTC Task Force proposed that responsibility for implementing and overseeing the reinsurance policy be given to the faculty Committee on Undergraduate Admissions and Financial Aid, currently chaired by Professor J. Kim Vandiver. On April 4, 1997, that committee released policy statements, implementing that portion of the April 1996 faculty motion dealing with reinsurance.

The following is the policy developed by the Committee on Undergraduate Admission and Financial aid on reinsurance of MIT Students who are disenrolled from MIT ROTC programs. Any MIT student who is disenrolled voluntarily or involuntarily from an MIT ROTC scholarship program is eligible to apply for the standard MIT financial aid packages and should do so to determine their level of eligibility. Any MIT ROTC scholarship student whose ROTC scholarship is terminated because of sexual orientation may also request supplemental loans beyond the standard financial aid package. The supplemental loans may be forgiven by MIT after the student has completed a period of public service. Students who choose not to perform public service will be expected to repay the supplemental loan and associated interest charges at the rate as stated in the MIT loan note signed at the time of receipt of funds.

During the course of our work, we have consulted with the Department of Defense. In the first instance, the discussion focused on explaining the faculty vote and exploring potential ways to create a program that would address MIT's educational mission within the constraints of the law. We also sought clarifications related to congressional action and federal laws. These early discussions also gave us an opportunity to explore the meaning of congressional actions taken after April 1996.

Our team, in consultation with others on campus, has decided that we will propose a set of modifications to the MIT AFROTC program. The result of our consultation on campus discussions suggests that this is our best chance to start the modification process. We are not presently considering proposals for other campus units though our expectation is that success in one branch will enhance potential for acceptance in other branches. Our proposal will focus on the on-campus educational offerings. Our goal is to develop a program that centers on leadership, team-building, and other personal skills that are consistent with our goals for undergraduate education. This thrust is consistent with other campus initiatives to develop leadership skills among our students.

In reviewing the Air Force curriculum, our team and the Assessment Sub-committee of the ROTC Oversight Committee have concluded that the program can be modified to highlight these activities in a substantial way, that such modifications would enhance its value to the ROTC cadets, and would make these elements of the program attractive to other MIT students as well. On the strength of this review we believe that we have a strong model. The proposal will be consistent with federal law.

On campus we have begun to search for ways to promote an improved climate for gay and lesbian members of our community. We have had informal conversations about our task with both individuals and groups in the MIT community. In recent weeks, we have briefed the Faculty Policy Committee, the Student Advisory Committee, and the Academic Council. In April, we met with the LBGT Issues Group (Lesbian Bisexual Gay Transgender), newly formed this year, to explore ways in which we might cooperate in seeking to improve the climate on campus and make our community more welcoming to all groups who are affected by discrimination. The discussions have laid the foundation for campus forums and other activities in 1997-98.

In preparing this report, the team acknowledged that there has been no progress in ending discrimination within the ROTC program since the faculty vote in April 1996. The legal barriers still exist. The team also recognized the difficulty that this issue has caused some members of our community who believe that any cooperation with a program that continues to discriminate is morally wrong. With this in mind, the team also acknowledged a

simultaneous obligation to oppose discrimination, assist those who might become its victims, press for change, even as we take every opportunity to provide leadership education to all MIT students.

STUDENT INFORMATION POLICY REVIEW

In December 1996, we began an Institute-wide review of student information policy and procedures. This review is being undertaken with an eye toward developing a policy to meet both the individual and institutional needs regarding the collection, use, and dissemination of information about students. Faculty, students, and staff are participating in this review that is scheduled to be completed in the Fall 1997. This work builds on the efforts of a number of staff members who had been meeting on this issue and of committees whose work has highlighted issues now being reviewed. The review is not intended to substitute for the work of other committees or offices, but rather to build on what they have accomplished.

No specific issue drives this review. There is a sense, however, that changes in technology, student service procedures, and expectations about privacy all suggest that we review and develop consensus about information policy.

In addition, specific offices, departments, and committees have internal procedures and traditions relating to student information. The goal is to consult broadly with faculty, staff, and student representatives, to identify areas where new policy needs to be made, old policy should be clarified, or where education about these policies and procedures is required.

INTERNATIONAL COUNCIL

The Associate Provost chairs the International Council which is composed of 15 faculty and staff from across the institute. The council has framed MIT's approach to globalism as follows:

- MIT is an American University committed to advancing research and education to improve global life and to promote international well-being by preparing students of all nations for a global workplace and by conducting research that advances the frontiers of knowledge.
- MIT's international initiatives should reflect our values as a community.
- International initiatives should support and promote excellence at MIT and should contribute to future excellence. International activities should contribute to strengthening research and educational capabilities at MIT.
- Research and Educational priorities for international initiatives are established by faculty.

One of the roles the council has is to advise the President and Provost on international matters. The council decided that the advice it gives will be guided by the broad mission noted above and not a detailed set of rules as some have proposed. In addition to advising on proposed initiatives, the council will also look for ways to foster international efforts, especially in areas that might not arise from the initiative of individual faculty members of a single department or laboratory. For instance, the council could identify a potential research and teaching area and bring faculty together with potential partners.

In closing out the year, the council agreed to consider what educational programs would advance the institute's education mission. A subcommittee will explore the issues related to courses and educational programs.

INTERNATIONAL SCHOLARS OFFICE

The International Scholars Office (ISO) assists MIT faculty and staff in bringing international researchers and professors to campus for a variety of purposes. The ISO advises on immigration matters, issues visa documents, and provides guidance, 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 served a total of 1,376 international scholars who were affiliated with MIT during the period 7/1/96 to 6/30/97. These scholars represented 66 different countries and 74 departments, laboratories and centers. Most of the scholars, 923, were sponsored under MIT's J-1 exchange visitor program, and 146 were sponsored by MIT on the H-1B visa. Twenty petitions for permanent residence were submitted on behalf of MIT faculty members and upper-level researchers.

The primary activity of the ISO is to provide ongoing assistance to these international scholars, their families, and their MIT hosts before and after the scholars' arrival to the US. In addition, advocacy to protect international educational exchange continues to be a major focus of the ISO. Massive immigration reform legislation entitled "the Illegal Immigration Reform and Immigrant Responsibility Act of 1996" was signed into law by President Clinton on September 30, 1996. Although the law seemingly addresses illegal immigration, numerous provisions have an impact on the MIT community. The ISO has been active, providing information about these provisions to MIT scholars and attempting to shape the regulations that will implement the various provisions of the law. A related development has been the Immigration and Naturalization Service Task Force. This Task Force has begun implementing a major pilot program in four southern states to improve the tracking and monitoring of international students and scholars, with the goal of applying such a system on a national level.

The ISO has a number of forums for advocacy. Jack Crowley, Director of MIT's Washington office, remains of invaluable assistance. The ISO Director continues to participate in the American Association of Universities Immigration Advisory Group, which has played a key role in representing the interests of international educational exchange. With the passage of the law, concentration has shifted from the legislative arena to the regulatory process involving the Immigration and Naturalization Service, Department of State, and United States Information Agency (USIA). ISO staff is active in NAFSA: Association of International Educators, with some staff members participating in monthly meetings, attending and making presentations at the regional and national conferences, and serving on working groups pertaining to J-1 and H-1B visa issues.

The Director joined NAFSA's regional Government Regulations Advisory Committee. In addition, the Director joined the newly-formed Consortium on Higher Education Immigration Issues, a group of 25 members that also includes MIT's Associate Dean from the International Students Office. This group has extensive internal communication and productive meetings with relevant government officials to interpret and influence regulations applicable to international students and scholars on our campuses. Other ISO and MIT challenges include implementing USIA's new regulations related to the J-1 Exchange Visitor program and addressing ongoing issues related to the Department of Labor's H-1B visa regulations.

Among other significant staff activities were the following:

- Preparation of customized annual reports for the United States Information Agency, the Institute for International Education, and MIT.
- Sponsorship of meetings for MIT administrators to address the role and procedures of the ISO and the basics of relevant immigration regulations.
- Organization and hosting of the annual workshop on taxes for international scholars.
- Co-hosting the annual International Open House for newcomers with the International Students Office. Hosting of the first reception for new international scholars and their families.
- Continued communication with the MIT community to help people distinguish between the Visiting Student category, administered by the International Students Office, and the scholar activity served by the International Scholars Office.
- On-going revision of informational booklets and flyers that give up to date information to international scholars and the MIT faculty and staff who host them.

Dana Bresee Keeth continues to serve as Director, Penny Sundberg remains as Advisor to International Scholars, Jennifer Stephens was hired as Advisor to International Scholars, part-time, replacing Diana Faust LeLacheur, Ivana Hrga-Griggs was hired as Assistant Advisor to International scholars, replacing Jennifer Wellman, and Katherine Linton was hired as Senior Staff Assistant, replacing Heather McConley.

MARTIN LUTHER KING VISITING PROFESSOR PROGRAM

The Martin Luther King Visiting Professor Program is intended to honor the life and contributions of Martin Luther King. Appointment as a visitor is open to individuals of any minority group. Visiting professors are associated with academic units at MIT and hold a title of Martin Luther King Visiting Professor. MLK professors are active in their various departments in a variety of ways including participating in research programs, pursuing their own research

or intellectual initiatives, teaching, and working with students. During this period, the Visiting Professors also participated outside the departments in activities that were open to the entire institute.

During 1996-97, five Visiting Professors were in residence. These included: Dr. Richard Joseph, Political Science Department from Emory University; Professor Oliver McGhee, Department of Civil and Environment Engineering from Georgia Tech; Professor Stephen Lee, Mathematics Department, from Argonne National Laboratory; Professor William Quivers, Physics Department, from Wellesley College; and Professor Walter Rodriguez (Fall term only), Department of Civil Engineering, from Tufts University.

During the year, the office consulted with the Martin Luther King Committee on the program, co-sponsored activities that featured the Visiting King Professors, including one session for minority graduate students to introduce them to the idea of college teachers.

Meetings with the Visiting Professors and consultation with the committee underscored the need to be more active in making sure that active recruitment takes place and that the needs of the visitors and the department are addressed in recruiting process. The MLK Committee produced a recruitment brochure and active efforts by the department resulted in commitments to 9 visitors for 1997-78, compared to 5 for 1996-7.

In addition to the regular support provided to the fellows, the Provost Office also provided funding to support the MIT Conference on African Renewal organized by Professor Richard Joseph. The conference brought several dozen scholars from Africa together for the three-day conference. Conference papers will be published in 1998.

OTHER ACTIVITIES

In addition to the major areas above, plus work in connection with the Academic Council and routine matters, I also participated as a member of the Board of the Boston Chamber of Commerce. The Chamber, among other activities, organized extensive activity to make presentations to members of Congress regarding the importance of research in medical and educational institutions in the Boston area.

The Associate Provost participated in the 20th Anniversary of the MIT Office in Japan and took the opportunity to review prospects for future collaborations there. We represented MIT at the Agenda 21 Conference in Beijing. This was an opportunity to explore a variety of projects on environment and infrastructure planned for the next century by the Peoples Republic of China. The office hosted or greeted visiting scholars from every continent, reviewed and consulted on international agreements and prospective initiatives.

Phillip L. Clay

ASSOCIATE PROVOST FOR THE ARTS

The focus of the Office of the Associate Provost for the Arts during 1997 has been threefold: The development of a greater sense of community and agency among MIT artists, further development of arts facilities and expansion of the program supporting Artists in Residence, especially in Science and Engineering.

THE ARTS COMMUNITY

The Associate Provost inaugurated the Arts Colloquia, monthly lunchtime meetings designed to introduce all members of the MIT Arts Community to the work of individual members in the different disciplines. This year's presenters were Peter Child (Music), Dennis Adams (Visual Arts), Alan Lightman (Writing and Humanistic Studies), Janet Sonenberg (Theater), Glorianna Davenport (Media Studies) and Henry Jenkins (Film and Media Studies).

The Creative Arts Council drafted a uniform Arts Acquisitions Policy for the permanent collection. The policy was endorsed by the Academic Council and duly reported to the Corporation.

In terms of the larger community, the MIT Office of the Arts, in collaboration with Escuela Internacional de Teatro de la America Latina y el Caribe (EITALC) cosponsored a two week workshop with Bread and Puppet Theater culminating in a performance, *Papier Mache vs. Neo-Liberalism*, on Kresge Oval in June. The bi-lingual performance featured MIT students, faculty and staff performing with members of the Bread and Puppet Theater and five Latin American and Caribbean theater companies.

In the same vein, members of the Gamelan Galak Tika appeared as featured performers at the World Music Festival at the World Trade Center in New York City.

After a successful trial year, MIT was awarded grants from the John S. and James L. Knight Foundation and The Pew Charitable Trusts of \$1.4 million each (for a total of \$2.8 million) to continue the Museum Loan Network (MLN) for three more years, October 1997-September 30, 1999. The Advisory Committee recommended 36 grants totaling \$402,580 which were approved by MIT for funding to museums throughout the country,

FACILITIES AND ACQUISITIONS

1997 also saw advances in facilities and arts acquisitions. The annual meeting of the Council for the Arts at MIT in October included the dedication of the Lipchitz Courtyard in Building 14 and in December over 200 guests celebrated the dedication of the new Rosalind Denny Lewis Music Library. Thanks to the generosity of Brad and Dorothea Endicott, the Endicott World Music Center began taking shape in N52. Preliminary studies toward a new home for the MIT Museum in the Metropolitan Warehouse and for a new performing arts facility began, as well.

The fall semester saw the installation of a new Bernar Venet sculpture, *Two Indeterminate Lines* (on loan from Corporation member Elliot Wolk) on the Sloan School Plaza and the gift of another piece, *TV Man or Five Piece Cube with a Strange Hole*, by David Bakalar presented by the artist. The MIT Museum hosted the opening of a holographic installation, *Light Forest*, by Betsy Connor. The Museum also initiated its educational outreach program with the opening of the new holography laboratory. As a part of the One Percent For the Arts Program, the renovations of Building 16 and 56 included the installation of apparatus to receive digital works from commissioned artists in its south wall while Susan Gamble and Michael Wenyan installed one of their works, on loan, in a north wall niche designed to hold holographic work.

ARTISTS IN RESIDENCE

Artists in Residence in science and engineering moved forward with residencies by photographer Felice Frankel in the Edgerton Center, sculptor Arthur Ganson in Mechanical Engineering, holographer Susan Gamble at the Haystack Laboratory and composer Diana Dabby in Electrical Engineering. The MIT Museum hosted an exhibition of Frankel's work in the Compton Gallery and an exhibition of Ganson's most recent kinetic sculptures in its main exhibition space.

Other collaborative residencies included actor George Takei (*Star Trek's* Mr. Sulu) sponsored by the Office of the Arts, Foreign Languages and Literature and Asian Studies; writer Maxine Hong Kingston in collaboration with

Writing and Humanistic Studies and Women's Studies; media artist Lawrence Weiner in collaboration with the Visual Arts Program and the Media Lab. Tina Packer and Shakespeare and Company spent the entire year as artists in residence with the Theater Program and will be returning for 1997-98. The Office of the Arts, in collaboration with Wellesley College also developed the series "Colored Girls with Pens: A Celebration of Prose and Poetry by Women of Color." The Endellion String Quartet, in residence in April of 1995, returned for another successful week of performances and master classes in April, 1997.

ACHIEVEMENTS AND HONORS

It was another year of individual achievement for faculty and staff in the arts as well. In theater, Associate Professor Janet Sonenberg's book, *The Actor Speaks*, saw publication. Professor Alan Brody's play, *Invention For Fathers and Sons* had its third national production at Theater Forty in Beverly Hills, while *Greytop in Love* had a reading at the Cherry Lane Theater in New York City featuring Academy Award winning actress Kim Hunter. October saw a performance of the dramatic oratorio *Reckoning Time: A Song of Walt Whitman*, with music by Professor Peter Child, libretto by Professor Brody and conducted by Senior Lecturer John Oliver. The performance was in honor of John Oliver upon his retirement from MIT. December saw the first performance of MITCAN, the MIT African Performance Ensemble, under the direction of Assistant Professor of Music James Makubuya. The Music and Theater Arts Section also dedicated its new harpsichord, from the premier builder Eric Herz, in Killian Hall with the premier performance of *things that flow*, a work by Christopher Adler '94. The harpsichord was a gift from the Council for the Arts at MIT. Senior Lecturer David Deveau continued his leadership of the steadily growing and universally admired Rockport Music Festival.

Professor Ellen Harris received the Class of 1949 Professorship Chair. Professor Lowell Lindgren became a Margaret MacVicar Faculty Fellow at MIT and received the Luise Vosgerchian Teaching Award from Harvard University. Theater Arts Lecturer Michael Ouellette received the Gyorgy Kepes Fellowship Prize for excellence in the creative arts.

In the Visual Arts, Professor Krzysztof Wodiczko continued to produce public works of international stature for the Ministry of Culture in France, the Andrezed Wajda Festival in Poland and a permanent work at PS 24 in New York City. Associate Professor Dennis Adams' *WAKE*, commissioned by the Neuberger Museum of Art, was installed at the State University of New York—Purchase. Associate Professor Ritsuko Taho created the Public Art Entrance to the National Women's Center Building in Tokyo, Japan and sponsored by the Ministry of Labor; Rakunoh-Shop (joyful farming shop) sponsored by the Kobe Earthquake Survivor Public Housing Community Art Project in Ahiya, Japan and *Serious Games* at the Barbican Art Gallery in London.

Kara Schneiderman, director of collections for the MIT Museum, won the Young Professionals Award of the Registrar's Committee of the American Association of Museums.

In addition, Mrs. Vera List, a long time patron of the arts at MIT and elsewhere, received the National Medal for the Arts from President Clinton. The nomination had been made by the Associate Provost for the Arts and prepared by Mary Haller, director of Arts Communications, and Katy Kline, director of the List Visual Arts Center. Professor Brody and Haller attended the ceremony in Washington.

Alan Brody

LIST VISUAL ARTS CENTER

The List Visual Arts Center's (LVAC) mission is to present, through changing exhibitions as well as the publicly sited Permanent Collection, the highest quality, most challenging art and design by professionals practicing in diverse media today and to provide additional educational programs which promote a broader appreciation of the ideas within contemporary visual expression.

HIGHLIGHTS OF THE YEAR

- LVAC receives organizational support grant of \$15,000 from Massachusetts Cultural Council, maximum award available to university-affiliated museums.
- *19 Projects*, LVAC publication documenting 10 years of its artists-in-residence wins design award from American Association of Museums.
- Independent Activities Period course on the design and execution of contemporary art exhibitions offered by Gallery Manager Jon Roll.
- WGBH produces 15 minute program on LVAC artist Joseph Kosuth to inaugurate new Arts Boston series highlighted outstanding regional cultural activity
- BRAVO/Continental Cablevision selects LVAC as one of 3 Cambridge cultural institutions to feature in its nationally distributed *Arts Break* program which profiles the arts in communities across the nation.
- LVAC sponsors a four evening screening and lecture series to overflow audiences on *The Art of Contemporary Cinema* by Henry Jenkins, head of MIT's Film and Media Studies
- LVAC collaborates with five area institutions to place new work by Joseph Kosuth in public spaces around the city.

EXHIBITIONS

Louise Bourgeois: Drawings (Hayden and Reference Galleries, October 5 - December 29, 1996). A retrospective of the works on paper by this eminent and influential artist; organized by the University Art Museum, Berkeley. Supplemented by one colossal scale steel *Spider* sculpture.

Joseph Grigely: Ordinary Conversations (Bakalar Gallery, September 12 - December 29, 1996). Deaf from age 10, Grigely collects and installs the scraps of paper with which he communicates with the hearing as he travels around the world. In residence for three weeks he conversed with large numbers of visitors, both students and the general public, whose notes were added to the exhibition. The first in the year-long Bakalar Gallery-based exhibition series of artists investigating the nature of language and communication. A 32 page artist-designed publication was produced.

Joseph Kosuth: Re-Defining the Context of Art and Public Media (Hayden Gallery, January 25 - March 29, 1997). This key figure in the redefinition of the art object that took place in the 60s and 70s surveyed his influential early use of public media (texts in newspapers and billboards) and created a new work placing quotes by cultural critic Walter Benjamin into six public spaces: The Brattle Theater, The Boston Center for the Arts, WGBH, the MIT Home Page, and Beacon Properties' prominent Government Center building Three Center Plaza.

PORT: Navigating Digital Culture (Reference Gallery, January 25 - March 29, 1997). The first dedicated museum site for the presentation of real-time live performance work over the internet by artists and artist groups from around the world. Organized in collaboration with Remo Campopiano of Artnetweb, New York. A special website and listserv was created for this project.

Jill Reynolds: The Shape of Breath (Bakalar Gallery, January 25 - March 29, 1997). The second in the Bakalar Gallery series of artist's projects dealing with language, this Seattle-based artist was in residence for eight weeks exploring the metaphorical properties of materials -- in particular their ability to convey, carry, and communicate. Working daily in the darkened gallery she blew more than 10,000 small glass bubbles, to underscore breath as a site of language production, giving form to that which is normally invisible and transient. A catalog will be produced.

Nahum Zenil: Witness to the Self (Hayden Gallery, April 19 - June 29, 1997). One of Mexico's best-known painters whose subject is his own face and body, which he uses to analyze the social, political and psychological circumstances of his society. This exhibition of 85 paintings and drawings was the first comprehensive survey of his work in the United States. Organized by the Mexican Museum, San Francisco.

Luis Gonzalez Palma: Photographic Works (Reference Gallery, April 19 - June 29, 1997). Continuing the focus on Latin American portraiture, the introduction to Boston of the dramatic, bitumen-treated photographs of individual Mayans by this Guatemalan architect turned photographer. He adds mythological and religious symbols to the figures as a means of evoking universal tragedies and loss.

Kay Rosen: Short Stories/Tall Tales (Bakalar Gallery, April 19 - June 29, 1997). Witty and colorful paintings of words which completed the year-long exhibition series on language. This Gary, Indiana-based artist turns words themselves into pictorial images, often relying on puns and popular culture, which ask the viewer to explore the ways meaning is read, derived and decoded. A 30-page catalog with silkscreened illustrations was produced.

EDUCATION PROGRAM HIGHLIGHTS

- Lecture by noted Professor Donald Kuspit, State University of New York Stony Brook, on the psychological dimensions of Louise Bourgeois's subject, imagery and working method.
- Slide talk by Jerry Gorovoy, Bourgeois's long time personal and artistic assistant.
- Lecture by Joseph Kosuth on the history of his work and its influence on conceptual art.
- Slide lecture and gallery talk on Latin-American portraiture by Nahum Zenil exhibition co-curators Professor Edward Sullivan of New York University and Clayton Kirking of Parsons School of Design.
- Lecture by Professor Steven Pinker, head of MIT's Department of Cognitive Neuroscience, on visual and other tricks of language in relation to Kay Rosen's work.

COLLECTIONS

The first piece of art to be placed in the renovated Building 56 through MIT's One Percent for Art policy, a multipartite hologram on loan from the artists Susan Gamble and Michael Wenyon, was installed only to require prompt removal to devise improved conservation conditions before eventual reinstallation. Fifteen works were added to the Permanent Collection by gift, including a sculpture by David Bakalar, placed between the Student Center and the Athletic Center. Four works were given to the Student Loan Collection. A painting on paper by Roni Horn was purchased for the Permanent Collection while 11 works on paper were purchased for the Student Loan Collection. A steel sculpture *Two Indeterminate Lines* by Bernar Venet was placed on long term loan by Elliot Volk and sited on the Hermann Building Plaza. Four works from the Permanent Collection required professional conservation.

STAFF NEWS

Katy Kline, director, served on the Museum panel at the National Endowment for the Arts; juried the public art competition for the Cambridge Water Treatment Plant for the Cambridge Arts Council; served as a final juror for the Bunting Institute Fellowship awards; continued to serve on the Visiting Committee for the Williams College Museum of Art and served as an advisor to the Brooklyn Academy of Music's Visual Arts Initiative.

Helaine Posner, curator juried the 86th Annual Exhibition of the Associated Artists of Pittsburgh for the Carnegie Museum of Art in October 1996.

Jennifer Riddell, curatorial assistant/fellow serves on the Public Art Advisory Committee of the Cambridge Arts Council.

More information about the List Visual Arts Center can be found on the World Wide Web at the following URL:
<http://web.mit.edu/lvac/www>

Katy Kline

MIT MUSEUM

The MIT Museum celebrated its 25th year in 1996 with a dinner in October for staff and friends as part of the Council for the Arts' annual meeting. During this event the establishment of the Warren A. Seamans Exhibitions Fund, to honor the Museum's recently retired founding director, was announced. A number of donors have made generous gifts to this endowed fund to support new exhibitions, which are such an important part of the Museum's work.

With funding from the Institute, the Museum was able to undertake a major project to expand and improve its collections storage space in the basement and second floor of N52. This space is now equipped with appropriate storage furniture and enhanced systems to monitor security and the environment. Another key development in FY97 was the increased activity of the Museum's Advisory Board. Two committees of the Board, the Collections Committee and the Public Programs & Outreach Committee, have been established to advise the Museum on the honing of its collections and programs to reflect the Museum's mission and best serve its constituency.

Intensified public relations efforts in FY97 resulted in widespread news coverage of the Museum which helped to increase visibility. Featured in stories on radio, television and in local and national magazines, the MIT Museum was also showcased in a lengthy article in *The Boston Globe*. The article dramatically boosted attendance for several weeks following its publication. In other efforts to broaden its audience, the Museum strengthened its affiliation with area arts and educational organizations such as ArtsBoston and the Massachusetts Teachers' Association and contracted with a brochure-distribution agency to disseminate its brochure at all local hotels and visitors' centers. To gauge its contribution to its audience, the Museum fine-tuned its visitors' survey and compiled an extensive report of the findings. A questionnaire was also sent to all staff members of the Institute and the results tabulated. The outcome of both surveys indicated an appreciation for many of the Museum's present exhibitions and programs and a demand for increased science and technology offerings.

COLLECTIONS

The Historical Collections continued to receive heavy use by the News Office, Alumni Association and various MIT offices and departments as well as outside researchers and institutions. Our collections of instruments, biographical material, photographs, films and tapes and MIT memorabilia grew through gifts from 27 donors.

COLLECTIONS MANAGEMENT AND INFORMATION SYSTEMS

Collections staff completed work begun in FY96 on producing a comprehensive Collections Management Manual. The Manual, which contains policies governing management of the Museum's permanent collections and newly developed procedures for implementing these policies, will significantly assist staff in effectively managing the Museum's extensive collections.

The MIT Museum Collections Committee was formed as an adjunct committee to the Museum's Advisory Board to work directly with collections staff to oversee development of the Museum's permanent collections through the review of proposed acquisitions to and deaccessions from the collections and the recommendation of appropriate actions to the Director. The Committee held an orientation meeting in May and will hold quarterly meetings beginning in August.

A major renovation project of selected collections storage areas began in November with the consolidation of Museum storage space in building N51/52. One storage room was renovated and new shelving added so that the Museum could relocate its approximately 10,000-piece science and technology artifact collection. Significant improvements were made to the storage environment to help preserve these important artifacts of MIT's history. In addition, space was renovated and conditions improved for storage of the Museum's Holography Collections.

Online visitors to the Museum's Web site increased to an average of 390 per week. In October, the Museum debuted its latest virtual exhibit, *LightForest: The Holographic Rainforest*, the online companion to an installation at the Main Exhibition Center. In January, Silicon Graphics chose the online exhibit *From Louis Sullivan to SOM* as its "Cool Site of the Week."

ARCHITECTURAL COLLECTIONS

The Architectural Collections of the MIT Museum rank among the top architectural drawings collections in the country and the world. Use of the Collections has increased dramatically over the past few years in terms of requests from researchers and use in exhibits, both at MIT and beyond. It is anticipated that this growth will continue over the next five years. In addition to answering requests for information and working with the Collections, the curator has continued to collaborate with other Institute departments on special projects such as developing exhibitions for the School of Architecture and Planning's Wolk Gallery and the Alumni Association. Planning and fundraising is also underway for a major Piranesi exhibition that will open at the Museum in December 1997. Funding for the position of curator has been extended through FY98, allowing for continuous coverage of the Collections.

HART NAUTICAL COLLECTIONS

The four-year Haffenreffer-Herreshoff Project was completed in the fall of 1996. As a result of this work, the MIT Museum recently published the 217-page *Guide to the Haffenreffer-Herreshoff Collection: The Design Records of the Herreshoff Manufacturing Company, Bristol, Rhode Island USA*, available for purchase at the MIT Museum Shop, Mystic Seaport Museum, Herreshoff Marine Museum and through *WoodenBoat* magazine's catalog.

Several initiatives were launched early in 1997 thanks to generous gifts. The Davis-Hand Project was fully funded by Michael McMenemy and Richard M. Davis '51 and is expected to be completed in Fall 1997. This project is similar to the work completed on the Haffenreffer-Herreshoff Project and involves plans cataloging and database and preservation microfilming. (The curator has developed a similar proposal for the George Owen (1894) Collection and is currently seeking funding for this project.) The Harmon Foundation, Inc. contributed funds for the purchase of an engineering copier. A Xerox model 2515 was acquired and now provides much greater flexibility in filling print requests. American Classic Voyages Co. funded cataloging and a database for 1,300 negatives relating to the SS *Independence* and SS *Constitution* in the Bethlehem Steel Collection. This donor is the parent company of American Hawaii Cruises which operates the SS *Independence* as a cruise ship in Hawaii and also owns the SS *Constitution*.

Two new exhibitions from the Hart Nautical Collections were mounted at the MIT Museum with funding from John Lednicky '44: *Maps from the Age of Atlases* and *Selections from the Hart Nautical Collections*. The curator has been in discussion with the Department of Ocean Engineering about renewing the exhibits in the Hart Nautical Gallery (Building 5) and the Department has committed funds and a UROP student to develop a permanent Ocean Engineering exhibit to open in the Hart Nautical Gallery in December 1998. Rather than replace the exhibit every several years, the plan will be to upgrade segments of the Ocean Engineering exhibit when new research or projects are available for interpretation.

HOLOGRAPHY

The Museum's collaboration with artist Betsy Connors culminated in the opening of *LightForest*, a permanent, large-scale installation that combines traditional landscape art and holography. This work was commissioned with principal funding from the AT&T Foundation's New Experiments in Art and Technology initiative. The Museum is now at work with guest curator Rene Barilleaux on a new holography exhibition, *Unfolding Light: The Evolution of Ten Holographers*, that will open at the Museum on September 20, 1997 and continue through February 22, 1998, and then travel to seven museums throughout the United States.

EDUCATION AND OUTREACH

The Museum's education program seeks to strengthen ties between MIT and the local community by inviting school and special interest groups to the Museum. Our goal is to demystify the scientific enterprise and make connections between art, science and technology. We are especially interested in helping our young visitors discover that they can become involved in the scientific enterprise at many levels, including professionally. The Museum has several unique resources that allow us to achieve this goal, including a world-class holography collection and a working holography lab. During the 1996-97 school year, the Museum drew on these resources to offer K-12 students and their teachers several age-specific activities, including demonstrations of how a hologram is made and activities related to the physics and chemistry of holography. Twenty-three schools and youth organizations participated in the education program and the education coordinator worked with 321 students in small groups so that each one could have a turn in the lab, receive individualized attention and make a hologram. This approach ensured that the students learned about all aspects of holography and it also resulted in their making a total of 44 holograms, which is a very

high success rate. News of this unique program has spread, in part through our publicizing it in the Massachusetts Teachers Association bulletin and other sources, but also through word of mouth and we expect it to remain in great demand.

The Museum enhanced outreach efforts in order to increase visibility and strengthen relationships with its constituencies. We hosted several lectures and gallery talks over the year, many in conjunction with exhibitions, including Arthur Ganson's popular series of noon-time talks about his work in *Gestural Engineering*. One of the most successful programs of the year was "Larry Gonick Week." In cooperation with several MIT departments, the Museum brought the internationally renowned cartoonist to the Institute for a one-week class on communicating difficult scientific subjects with cartoons. In addition to teaching a general course on "cartooning science," Gonick addressed several classes and taught a middle-school day camp affiliated with the Center for Materials Science and Engineering. Gonick also delivered a campus-wide lecture.

NEW EXHIBITIONS

GALLERIES AT THE MAIN EXHIBITION CENTER

LightForest: The Holographic Rainforest opened October 19, 1996 as a permanent installation and is artist Betsy Connors' holographic interpretation of a rainforest.

Gestural Engineering: The Sculpture of Arthur Ganson opened on January 10, 1997 and is ongoing. Ganson's kinetic sculptures exude the wit of their creator, who is an Artist in Residence at MIT and a self-described cross between a mechanical engineer and a choreographer.

What's So Funny About Science? The Cartoons of Sidney Harris, January 10 - May 31, 1997, presented a hilarious look at unexpected and incongruous moments in science by the well-known *New Yorker* cartoonist.

Maps from the Age of Atlases, August 5, 1996 - May 4, 1997, featured rare maps from the Hart Nautical Collections that illuminate the golden age of cartography.

Selections from the Hart Nautical Collections opened on June 10 and will run until November 2, 1997.

COMPTON GALLERY

On the Surface of Things: Images in Science & Engineering, February 14 - June 27, 1997, featured stunning photographs by MIT Artist in Residence Felice Frankel that communicate recent research in a variety of disciplines at MIT and other institutions. This popular exhibition will move to the Museum and be on view from July 15 - November 2.

MUSEUM SHOP

The MIT Museum Shop had its most profitable year since FY91 due to a 20% increase in sales at the Museum location and more efficient catalog production. However, our most important achievement was publishing *Is This The Way To Baker House? — A Compendium of MIT Hacking Lore*, the long-awaited sequel to *The Journal of the Institute for Hacks, Tom Foolery and Pranks at MIT*. The book contains essays, anecdotes and interviews with members of the faculty, administration and staff as well as current and former students.

More information about the MIT Museum can be found on the World Wide Web at the following URL:
<http://web.mit.edu/museum/>

Diego Garcia, Kurt Hasselbalch, Mary Leen, Kara Schneiderman, Kimberly Shilland, Kathy Thurston-Lighty, Michael Yeates

MUSEUM LOAN NETWORK PROGRAM

The Museum Loan Network (MLN), a program funded by the John S. and James L. Knight Foundation and The Pew Charitable Trusts, was launched in October 1995 to promote collection-sharing among museums in the United States. The program, administered by the Office of the Arts, was created to encourage museums across the country to tap the potential of one of their most valuable but underutilized resources: artworks currently in storage. By making grants available to both borrowing and lending institutions for long-term loans, the MLN is helping these organizations bring to light thousands of artworks that lie hidden in storage rooms across the country and simultaneously broadening collections of borrowing museums.

After a successful trial year, MIT was awarded grants from the John S. and James L. Knight Foundation and The Pew Charitable Trusts of \$1.4 million each (for a total of \$2.8 million) to continue the MLN for three more years, October 1997-September 30, 1999.

The MLN selected a new Advisory Committee drawn from members of the national museum community, completed the design of the program, refined the database, actively promoted the program to the museum community to encourage and assist museums in participating and finally awarded grants to selected museums. This year the MLN put a strong emphasis on contacting individual museum curators to encourage networking in that facet of the museum community.

Development continued on a key element of the MLN: the MLN Directory, a practical means of identifying art objects available for long-term loan. The MLN staff began to add and edit entries to the MLN Directory which will be accessible to the museum community through the World Wide Web. These entries are comprised of information concerning art objects available for long-term loan to the nation's museums. The technological components of the database are being developed by MIT's Center for Educational Computing Initiatives.

Two press releases concerning grant awards were distributed to 1,300 museums, related organizations and the press. Five thousand copies of an informational brochure, produced in May 1996, were distributed at museum conferences and by mail. The Museum Loan Network home page was launched in April 1996.

The MLN director lectured about the program at the American Association of Museums (AAM) Conference in Atlanta, the College Art Association in New York, the Mid-Atlantic Museums Association in Long Island, the Museum Trustees Association in San Francisco, the New Mexico Museums Association in Taos, the AAM Curator's Roundtable, Washington, DC and the AAM University Museums and Galleries Roundtable, Washington, DC.

The MLN awards two types of grants to eligible nonprofit institutions in the United States: planning grants and implementation grants. In the January 1997 and June 1997 Advisory Committee meetings held at MIT, 36 grants totaling \$402,580 were recommended to be approved by MIT for funding to museums throughout the country, including survey grants to such prestigious institutions as the Museum of Fine Arts, Boston; the Museum of Art, RISD; the Duke University Museum of Art; and the Museum of Contemporary Art, Chicago. Travel grants were awarded to, among others, the Anchorage Museum of History and Art, the Corning Museum of Glass, the Joslyn Art Museum, the University of New Mexico Art Museum, and the Mexican Museum, Chicago. Implementation grants were awarded to such diverse institutions as the Lowe Art Museum, Miami; the Columbus Museum, Georgia; the Williams College Museum of Art, MA; the Clarksville-Montgomery Museum, TN; and the Huntington Library, CA.

More information about the Museum Loan Network can be found on the World Wide Web at the following URL:
<http://loanet.mit.edu/Web/>

Lori Gross

OFFICE OF THE ARTS

ARTS COMMUNICATION

In the eighth year of the Office of the Arts, Arts Communication published and disseminated up-to-date information on MIT's arts programs and events while promoting and cultivating awareness of the arts at MIT, both within and outside the Institute. Significant accomplishments and events included the publication of a feature story on Associate Provost for the Arts Alan Brody and the arts at MIT in *The Chronicle of Higher Education*; the placement of an op ed piece by Professor Brody in *The Boston Globe*; the awarding of the 1996 National Medal of the Arts to MIT art patron Vera List; targeted outreach to prospective MIT students expressing interest in music and/or theater; and a significant increase in the number of MIT arts-related photos in MIT's student newspaper, *The Tech*.

INTERNAL (MIT)

For the second year in a row, MIT's admission application included tear-out postcards for prospective students to request information on the arts at MIT and indicate specific arts interests. Postcards were returned from 2,472 individuals and a copy of the *Student's Guide to the Arts* was sent to each with a letter from Associate Provost for the Arts Alan Brody. Students who were eventually admitted and who had indicated interests in theater were sent congratulatory letters from Professor Brody and Assistant Professor Janet Sonenberg giving specific information on opportunities in theater at MIT. Admitted students with interests in music were sent congratulatory letters from Professor Peter Child with information on opportunities in music at MIT.

For the eighth 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 were compiled and written by Lynn Heinemann, edited by Mary Haller. The director of arts communication attended weekly News Office meetings and continued to work closely with its staff. Arts Page stories and arts information were made available on-line through Tech Info and the World Wide Web. Copies of the Month-at-a-Glance Arts Page (including two two-pagers) were mailed monthly to 739 individuals at their request.

Thirteen feature arts-related stories and eight arts-related photos-with-captions were published in *Tech Talk's* general spaces, including four stories and two arts photos on the front page. Authors included Mary Haller and Lynn Heinemann of the Office of the Arts, members of the News Office staff and members of the MIT arts community.

The number of MIT arts-related photos in *The Tech* rose significantly -- with many appearing on the cover of the paper -- due, in part, to a partnership cultivated with *The Tech's* photo editor, graduate student Gabor Csanyi. Through Mr. Csanyi, Arts Communication also made significant additions to its collection of stock photographs.

Calendar listings of MIT arts events were produced and mailed monthly to 272 members of the electronic and print media. Press releases and posters were produced for major events and announcements and mailed locally and nationally to targeted writers and media sources.

A World Wide Web site for the arts at MIT was maintained, publicized and linked to numerous other Web pages and sites by Lynn Heinemann. Information on the home page was reorganized to make the page more user-friendly and work began with a designer to add images and design elements to the site.

The Director of Arts Communication represented the Office of the Arts and gave presentations on the arts at MIT during Parent's Weekend and Campus Preview Weekend (for prospective women and minority students).

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" (253-ARTS).

LOCAL AND NATIONAL ATTENTION

"Under the leadership of associate provost Alan Brody, MIT is expanding its intellectual horizons to emphasize the arts as well as technology," announced *The Chronicle of Higher Education* in a December 13, 1996 feature story entitled "Where Art and Science Meet." The story described MIT's commitment to the arts over the past eight years and efforts by Professor Brody to integrate the arts into the culture of MIT and featured photographs of Professor Brody, MIT student artists and past artists in residence. "There's an energy in the air at M.I.T. that is difficult to

describe but is palpable nonetheless,” said writer Zoe Ingalls, who referred to MIT’s over 400 yearly events as “a variety [that] is astonishing at an institution devoted to science and engineering.” The story included comments by Professor Brody, Professor Alan Lightman, Professor Ellen T. Harris and senior Richard Y. Lee.

MIT benefactor Vera List was awarded the prestigious 1996 National Medal of the Arts by President William Clinton. Professor Brody and Director of Arts Communication Mary Haller attended the January 9 ceremony in Washington, DC. Mrs. List was nominated for the award by Professor Brody; the nomination materials were prepared by Katy Kline, director of MIT’s List Visual Arts Center and Ms. Haller.

An essay written by Professor Brody was sent to publications across the country including the *Boston Sunday Globe*, where it was published as an op ed piece on March 30 (“The only legitimate rationale is still ‘arts for their own sake’”). The article was reprinted in MIT’s *Tech Talk*. Professor Brody was also interviewed and quoted extensively in a cover story in the *Boston Globe Sunday Magazine* by theater critic Ed Siegel.

“MIT might well be called the hidden treasure of the art world, or at least of the Cambridge area,” the *Cambridge Current* concluded in a multi-page lead feature titled “Art at MIT: Surprising Intersections.” The article recounted MIT’s historical commitment to the arts and cited the Artist in Residence Program, the murals in Walker Memorial, exhibitions at the Museum’s main galleries and the Hart Nautical Gallery, the List Visual Arts Center and the volume of music, theater and dance events.

The MIT Museum was featured in a *Boston Globe* story entitled “High-Tech High Jinks”, which ran on the front page of the Living/Arts section and was accompanied by color photos. Writer William A. Davis noted that the Museum is a “great place for an entertaining and inexpensive family excursions.”

Recognizing that MIT could, for the first time, boast three substantial programs in “world music” (Gamelan Galak Tika, MITCAN and MITHAS) each offering public performances, Arts Communication presented their spring concerts together as a series in the form of ads and flyers. The ads were placed in the World Music program booklet and *World Rhythm* magazine. The flyers were mailed locally and distributed at MIT music events.

Press attention was also cultivated for these three world music programs. “With more composers in its music department than most conservatories and a great variety of student ensembles (including the Boston area’s only Balinese gamelan), M.I.T. is a hotbed of music,” declared the Boston-based *World Rhythm* magazine in a cover story entitled, “Opening a door to the world...Music and Dance at M.I.T”. “Factor in a multinational, multilingual, multitiered student population and you have an environment where international music and dance can really flourish,” continued the article, which concluded that “...while MIT may be best known as a school for science and technology, in its comprehensive and innovative music programs, it is ahead of many conservatories.” In addition, numerous photos ran in local publications prior to Galak Tika’s November 16 performance, helping to attract an attendance totaling nearly 750. The concert received a glowing review by the *Boston Phoenix*.

WGBH-TV’s “Greater Boston Arts,” a new program on Boston culture, showcased Artist in Residence Arthur Ganson’s kinetic sculptures from the MIT Museum’s permanent installation, *Gestural Engineering: The Sculpture of Arthur Ganson*. They also visited the List Visual Arts Center to interview Joseph Kosuth and highlight his exhibition, *Re-Defining the Context of Art: 1968-97*.

Local media attention was cultivated for various MIT artists in residence and guest artists sponsored or co-sponsored by the Office of the Arts, including Maxine Hong Kingston, George Takei, Kenny Leon, The Endellion String Quartet, The Last Poets and Bread & Puppet Theater. *The Boston Globe*’s “Names & Faces” column ran separate photos of Mr. Takei and Mr. Leon, showing each interacting with MIT students. Tina Packer, founder and artistic director of Shakespeare & Company — in residence at MIT with members of her company — was the subject of feature stories in both *The Boston Globe* and *Boston Herald*. In previewing a performance sponsored by the MIT Office of the Arts and IBA/ETC’s Cafe Teatro, Bob Young referred to the “sense of adventure that IBA and MIT have exhibited for years now.”

Other local press attention included announcements of the dedication of MIT’s new Rosalind Denny Lewis Music Library; numerous positive reviews of exhibitions at the List Visual Arts Center; coverage of Tod Machover’s

“Brain Opera,” and coverage of performances of “Estampas Mexicanas,” a composition by 1995 graduate Jose Elizondo.

More information about the Office of the Arts can be found on the World Wide Web at the following URL:
<http://web.mit.edu/arts/>

Mary L. Haller

COUNCIL FOR THE ARTS

This year was the first full year with Alan Brody as Associate Provost for the Arts and Susan Cohen as Director of the Council for the Arts. A renewed focus on outreach to different parts of the country was launched, with trips to Los Angeles and Chicago and the formation of a new committee, the Special Events Committee. The Council would ultimately like to establish “satellite” groups: clusters of Council Members in Southern California, Dallas, Chicago and perhaps cities in Europe.

COUNCIL STANDING COMMITTEES

Annual Meeting (Catherine N. Stratton and Dorothea Endicott, co-chairs). The Annual Meeting committee presented a wonderful event, the 24th Annual Meeting, on October 24 and 25, 1996. One hundred twelve Council Members and guests attended. The meeting was organized to highlight Theater Arts, one of the six curricular arts disciplines taught at MIT. President Charles M. Vest and Provost Joel E. Moses addressed the Council on MIT affairs and Associate Provost for the Arts Alan Brody expressed his hopes for the arts at MIT at the Friday morning business meeting in Bartos Theater. The 25th Anniversary of the MIT Museum was celebrated at the Meeting, honoring Warren Seamans, the Museum’s first Director, who retired this year.

The Eugene McDermott Award and the Gyorgy Kepes Fellowship Prize were presented, respectively, to Kenny Leon, the Artistic Director of the Alliance Theater in Atlanta, GA and Michael Ouellette, instructor in the Theater Arts Section (see Special Programs below).

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

Development (Martin N. Rosen ’62, chair). Sixty-four Council members provided unrestricted contributions averaging \$3,349. Nineteen non-member donors contributed unrestricted gifts averaging \$273. The total raised was \$219,864. In addition to unrestricted gifts, 21 members provided designated contributions totaling \$486,982 to other MIT arts programs. These include the creation of the new Endicott World Music Center, an exhibition fund in honor of MIT Museum Director Warren Seamans and the rejuvenation of the Max Wasserman Forum on Contemporary Art.

Grants Program (Bradford M. Endicott ’49, chair). Under the leadership of Chairman Bradford M. Endicott ’49, \$65,000 in the form of 41 grants were awarded to projects such as a series of actors’ workshops with a dream analyst, a spring tour of the MIT *a cappella* group, the Chorallaries and geothermal sculptures installed on Kresge oval.

Membership (Bernard G. Palitz ’47, chair). At the writing of this report (7/97), Council membership stands at 87, plus five *ex officio* members. Six individuals accepted appointment to the Council upon the invitation of President Vest: Raj Arulpragasam ’77, Jan Fontein, Sheldon Razin ’59, Edith and Frank Wyle ’41 and Phoebe Zaslove. With deep sadness this report must note the passing of the following beloved members of the Council: Mrs. Frances Fahnestock, Miss Agnes Mongan, founding member Mr. Paul Tishman ’24 and Mr. Alan W. Katzenstein ’42.

Special Events Committee (Catherine N. Stratton, chair). A new committee, formed to work with the Director of the Council in planning events and excursions for current and potential Council members around the world, organized to involve the arts at MIT when possible.

List Visual Arts Center (LVAC) Advisory Committee (Kitty Glantz, chair), **MIT Museum Advisory Board** (Harvey I. Steinberg '54, chair). Both committees were spun off as "affiliated Committees" in FY96. The chairs of the committees sit on the Executive Committee of the Council, which annually allocates funding to both to be used at their respective directors' discretion. The List Visual Arts Center received \$15,000 and the MIT Museum \$20,000.

Artist-in-Residence Committee (Stephen Memishian, chair). Organized along the lines of the MIT Museum and LVAC Boards described above. This committee will work with MIT Office of the Arts Director of Special Programs Maureen Costello and a panel of arts professionals, Council Members and artists in bringing artists to the MIT campus to work within all departments of the Institute.

SPECIAL PROGRAMS

From January 16-20, 1997, 30 Council members and friends explored the Los Angeles area, on the lookout for art, music, culture, haute cuisine and new Council Members. As a result of the trip, former members Edith and Frank Wyle re-joined the Council and Sheldon Razin '59 became a new member.

On May 4, 1997, a small group of Council members met at the Guggenheim Museum to see the Ray Nasher collection on exhibit. Nasher, a Council member, met with the group prior to our tour and discussed his collecting policy. Later that day the group attended a concert in the World Financial Center featuring MIT's Gamelan Galak Tika under the direction of MIT Music Professor Evan Ziporyn.

On May 16, 1997 a small group of Council members gathered in Chicago to attend a Chicago Symphony concert and visit the new Museum of Contemporary Art. Chicago-based Council members Robert '63 and Bonita Levin and Martin Zimmerman '59 were our hosts.

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 10 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 Open Rehearsals, 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 each event enjoying full attendance, with an average of 50 students per event. The Council provided tickets to see the following: Tom Stoppard's *Arcadia*, the Huntington Theater's *Journey to the West*, the Cantata Singers, World Music's Grupo Afrocubano de Matanzas, Anna Deveare Smith in *Twilight*, the hit musical *Rent*, the play *Blues for an Alabama Sky*, directed by McDermott Award winner Kenny Leon, a stage adaptation and screening of *Cabinet of Doctor Caligari* featuring MIT Music Professor Martin Marks as accompanist for the film and Boston Baroque's production of *Don Giovanni*.

The Gyorgy Kepes Fellowship Prize was presented by Alan Brody to Michael Ouellette, lecturer in the Theater Arts Section at the Annual Meeting luncheon on Friday October 25. Also at the Annual Meeting, the *Eugene McDermott Award* was presented by Ida Ely Rubin and Dorothea Endicott (McDermott Award Committee co-chairs) to Kenny Leon, actor and Artistic Director of the Alliance Theater in Atlanta. Instead of the usual acceptance speech, Mr. Leon electrified the audience at the Sonesta with a theatrical monologue.

At the Institute Awards Convocation in May Professor Peter Child and Janet Sonenberg presented the *Laya and Jerome B. Wiesner Student Art Awards* to MIT Dance Troupe, Tara Perry '96 and Solomon Douglas '96. The *Louis Sudler Prize* was presented to Grant Ho '96 for his achievement as a musician.

More information about the Council for the Arts can be found on the World Wide Web at the following URL:
<http://web.mit.edu/arts/camit.all.html>

Susan R. Cohen

SPECIAL PROGRAMS

With support from the new Associate Provost for the Arts, Special Programs expanded the broad presence of artists in the humanities by creating new programs and alliances, further developed the model for artists working in the sciences and engineering and continued to renew and sustain internal and external cultural alliances to support and strengthen the diverse mission of the Program and the Institute.

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

The MIT Program in Women Studies and Women's Studies at Wellesley collaborated with the Office of the Arts to produce *Colored Girls with Pens: A Celebration of Prose and Poetry by Women of Color*. Local, regional artists and a group from the Pacific-Rim, The Bamboo Ridge Collective, participated. The Office of the Arts with Professor Shigeru Miyagawa of Foreign Languages and Literatures and an Institute-wide team, implemented an extensive residency with Asian-American actor and activist George Takei of "Star Trek" and engaged the MIT community in far-ranging discussions about the Japanese internment, the American film industry, technology and culture, in a symposium titled *Racism in the Arts*. Strong student participation was apparent throughout. Subsequently, a Residency Planning Committee was formed in the Foreign Languages and Literature Section bringing the total to three such committees in the School of Humanities.

An additional high visibility program with author Maxine Hong Kingston reaffirmed our connections with the Asian and Asian-American community internally and externally.

Residency committees in Music and Theater Arts realized programs with actor and director Kenny Leon, hip-hop dancer Rennie Harris and computer music percussive and bass duo, Basso Bongo. The advanced work of music composition students was played and critiqued by the Endellion String Quartet during a second Residency which also offered two free classical concerts.

SCHOOL OF ARCHITECTURE

In collaboration with the Visual Arts Program, Lawrence Weiner, illustrious conceptual artist, led students from MIT, Harvard and Massachusetts College of Art in an intensive three week workshop which questioned and explored the nature of the Internet as a non-traditional public art space.

SCHOOLS OF SCIENCE AND ENGINEERING

Six artists continued to break ground in the on-going initiative to create productive pairings between artists and the faculty in science and engineering. Exhibitions of science photography by Felice Frankel, based in the Edgerton Center and kinetic sculpture by Arthur Ganson, based in Mechanical Engineering, provided platforms for discussions about creative process and the intersection of art and science by each artist. Diane Dabby, composer and electrical engineer, continued work on her innovative composing approach, *Musical Variations from a Chaotic Mapping* in the Electrical Engineering area. Holographers/photographers Susan Gamble and Michael Wenyon began a residency at the Haystack Observatory where holography and radio astronomy are coming together in photographic exhibitions and a web-site Residency unique to the world of radio astronomy. The humorous side of science was put forth by cartoonist Larry Gonick in drawing workshops, classes and public programs.

COLLABORATIONS

Special Programs continued on-going guidance and support to student groups and staff to bring professional artists to the Institute. Soul@MIT, the cultural arm of the Black Student Union, brought *The Last Poets* to MIT for public programs and writing workshops. Numerous others were assisted in assessing the feasibility of program design, development and implementation.

A successful five year collaboration with IBA Arte y Cultura, a Boston based Latino cultural agency came to an end as this agency closed its doors. Festival! a concert program of Latino jazz marked this milestone. On-going partnerships with the Cambridge Multicultural Arts Center and World Music continue.

The academic year ended with a two week international collaboration in Vermont with the MIT Theater Section, Bread and Puppet Theater in Vermont and EITALC, the International School of Theater of Latin America and the Caribbean. Performances in Vermont and at MIT of this large-scale project re-affirmed our commitment to

innovative community partnerships on a local and international scale and created new alliances with the Latin American community.

The Director of Special Programs reviewed work for the Theater Panel of First Night Boston and The LEF Foundation and was invited to participate in The World Century Campaign/Millennium Initiative sponsored by the Harvard Business School.

Advisory Board membership at First Expressions, a Student Art Gallery in Boston continues.

Special Programs maintains a commitment to diversity through aggressive program development and support and through formal work on two Institute committees: the Dr. Martin Luther King, Jr. Annual Committee and as new appointee to the Campus Committee on Race Relations.

The List Fellowship supports work in the performing, visual and literary arts by students of color and in its fifth year has finally matured as envisioned by the minority community who developed it. After a photography trip to Peru in the summer of 1996, the Wiesner Gallery exhibit by Kori Bevans '97 clearly showed how a student can benefit from the resources the Fellowship affords. Eto Otigbe '99 was awarded the 1997 Fellowship and began summer work in printmaking and painting at The Printmaking Workshop in New York.

The Artist in Residence Program nominated and selected its Advisory Board members. A September meeting is planned.

A Senior Staff Assistant position was created and Holly Kosisky was hired.

More information about the Special Programs of the Office of the Arts can be found on the World Wide Web at the following URL: <http://web.mit.edu/arts/specprogs.all.html>

Maureen Costello

DEAN FOR UNDERGRADUATE EDUCATION AND STUDENT AFFAIRS

MIT was founded on the principle of integrated education: a single faculty, a common core, and a curriculum that combines general and professional learning. This year, for the first time in MIT's history, an administrative organization was established to provide an appropriate institutional structure to support this integrated education. On October 1, 1996, President Vest consolidated what had been three different reporting lines and thereby brought together most of the central Institute functions supporting student life and undergraduate learning. This consolidation was intended to make the delivery of academic and campus services more efficient and effective. In addition, it reaffirmed and strengthened the principle of integrated education. The new dean's office articulates the message that learning takes place everywhere at MIT — not only in laboratories and classrooms, but also in residential life, athletics, and student activities.

This report is arranged to reflect the three main areas of activity in the Office of the Dean of Students and Undergraduate Education or ODSUE: academic and financial information services (the Bursar's Office, the Registrar's Office and the Student Financial Aid Office; Student Information System); academic support services (Undergraduate Academic Affairs; Admissions; the Educational Council; Career Services and Preprofessional Advising; Counseling and Support Services; and the Office of Minority Education), and campus life services (the Campus Activities Complex; MIT Card, Housing and Food Services; Committee on Discipline/Student Conflict Resolution and Disciplinary Procedures; and Residence and Campus Activities; the Reserve Office Training Corps; and the Department of Athletics, Physical Education and Recreation). The report begins with an overview of the transition to the fully integrated dean's office.

TRANSITION AFFINITY TEAMS

In the months since the creation of the new office, we have moved forward to realize administrative efficiencies. Staff members from different offices came together in affinity teams, each with a leader, to carry out the transition projects based on common processes:

Currently, the many departments making up the new office are spread all over the campus. The goal of the Administrative Facilities project is to develop a space plan that will consolidate these facilities and thereby support the integration of the office.

The communications affinity team's goal is to create a comprehensive strategy for communicating with students, faculty and other members of the MIT community. This involves mapping present communications and publications, understanding student services' communications needs, and developing strategies for meeting them.

The goal of the Facilities Management project is to create a management program that provides a high and consistent level of maintenance for all the major facilities managed through the office: Athletics, the Campus Activities Complex, and Housing (including independent living groups).

The goal of the Financial Operations Planning and Management project is to provide the office with standardized financial tools (including SAP) and access to financial information. The office will use these improvements to set priorities, identify opportunities for revenue generation, and improve cash management.

While some parts of the new office have participated actively in fundraising, many others have not. There has not been a long term, comprehensive strategy to raise funds for common educational needs, both academic and campus-based. The goal of this project is to develop and implement such a strategy.

The goal of the Human Resources project is to implement consistent and equitable human resources practices that support staff satisfaction while advancing the mission of the new organization. These include descriptions of responsibilities and performance criteria for all positions, as well as fair standards for compensation and rewards.

The goals of the Information Technology project are to provide information management tools and processes for hardware, software and networking; to prioritize systems developments; to provide technical training; and to improve data management throughout office.

The goal of the Social and Identity project is to develop a strong sense of community and purpose among the more than 400 staff members who now make up the new office, and to improve office wide communications (for example, through the electronic newspaper, *View from the Dome*, spearheaded by Catherine Taylor).

The new dean's office will require skills and competencies that support change and encourage staff creativity and development. The Training and Development project will identify these skills, provide the training programs needed to develop them, and develop the standards to measure their effectiveness.

SPECIAL PROJECTS

We have also pursued a variety of special projects, many of them started under the auspices of Student Services Reengineering, to improve educational support services for students and faculty. The special project teams range from ones that are already well advanced to ones that are just getting underway. The most advanced effort to date is the Financial and Academic Services Transition (FAST), which combines student academic and financial information services that were previously dispersed among several offices. Also well along is the Residential System Integration Team, which is bringing together operational and programmatic activities in residential and campus activities. Other major projects are Cocurricular Integration, Career Assistance Redesign, and the redesign of graduate admissions and food services. Projects to integrate and enhance educational support and personal support services have also started during the past six months; both promise to have far-reaching effects.

Teams have been trained in project management, so that they have developed scope statements, work schedules, budgets, and metrics for measuring success. Team leaders coordinate the new initiatives with other teams and with existing offices. To emphasize this coordination, in this report we have integrated the special projects descriptions within the office reports.

This report summarizes an extraordinary amount of activity and change in the months since the formation of ODSUE. This record is even more remarkable considering that it has been accomplished at a time when staffing has generally been reduced, mainly due to the early retirement incentive plan, and when three leadership positions--the registrar, the dean of admissions, and the director of career services and preprofessional advising--are vacant. Separate search committees have been established for each position with a common staff support team.

The office seeks to win the respect of the MIT community as an organization that bears significant responsibility for the overall quality of the educational experience of our students. This goal was emphasized by our visiting committee, which joined us on April 1-2. The occasion, heralded by a late-season blizzard, was made more dramatic than usual because we knew we were witnessing the emergence of a new organization that could potentially play a major role in shaping the educational future of MIT. The following report describes how we are beginning to meet this challenge.

Rosalind H. Williams

FINANCIAL AND ACADEMIC SERVICES TRANSITION

FAST began the year as a reengineering effort and became part of the Office of the Dean of Students and Undergraduate Education when it was expanded in October 1996. The goal of FAST is to improve student access to administrative transactions and to reorganize the offices of the Registrar, Bursar and Student Financial Aid into an improved client-focused service organization. Originally included in these reorganization plans, the Student Information System Department (SIS) will now take on a broader enabling function for the entire new organization.

A team of administrators and MIT Student Information System (MITSIS) developers created an integrated graduate awards appointment system that enables departments to make graduate awards online and electronically notify students instantly about their funding. The new system has reduced the error rate significantly and has eliminated 70,000 pieces of paperwork. The team also developed standard reporting procedures for all departments to use with the system. The report applications were the first widespread implementation of MIT's new data warehouse, where stored data from different administrative functions are available for integrated reporting.

Centrally located on the Infinite Corridor, the new Student Services Center facility provides one-stop shopping for many financial and academic services, saving students both long journeys to the far reaches of the campus and visits to several offices to settle one piece of business. The pilot has served thousands of students a month and has significantly reduced traffic in the Bursar, Registrar and Student Financial Aid offices. The expanded, full service center opens in Building 11 in August 1997.

Students now have access to personal financial and academic information via WebSIS (Web Student Information System) on the World Wide Web. They can check their grades, registration status, and progress toward fulfilling the general Institute requirements; they can update addresses; and they can review their student account statements, their financial aid status (requirements tracking and award information), and loan information from anywhere in the world where they have Web access.

Starting in May, all continuing students were able to pre-register with WebSIS. The system allows students to build their schedule grid using the integrated subject listings/schedule and automatically pre-register their choices. Students can also enter emergency contact and religious preference information.

The accuracy, layout and language of the Bursar's bill has been significantly improved, and the time it takes to credit MassPlan loans has been significantly reduced.

During the coming year, FAST will complete its reorganization efforts. The four FAST offices will be centrally located in one place. The expanded Student Services Center will open in August, offering more efficient services to undergraduate and graduate students.

The new processes our staff are now developing will make it possible for students to complete registration and financial transactions in a single location, assisted by staff members who are able to provide a wide range of services previously reserved for the independent offices.

Stanley Hudson

BURSAR'S OFFICE

The mission of the Bursar's Office is to organize tuition, loans, and related fees; to counsel student and alumni borrowers on payment options; and to assist the vice president for finance and treasurer in evaluating and selecting student loan funding sources.

MIT continued to participate in the federal William D. Ford Direct Stafford Loan Program. Because the federal government changed loan services, administering the program remained stressful. MIT also provided resources to develop and deliver on-demand printing of promissory notes for Perkins and MIT Technology Loans.

At the end of FY97, student loans receivable equaled \$64,741,296. Of this total, \$17,405,564 came from MIT loan funds established by alumni and friends; \$27,707,995 came from federal support of the Perkins Loan Program; and \$19,627,737 was borrowed from the Student Loan Marketing Association.

In 1996, MIT's cohort default rate on Perkins/National Direct Student Loans was 1.3 percent; and on Stafford/Guaranteed Student Loans 2.8 percent. We take pride in the good performance reflected in these rates.

The Bursar's Offices continues to support systems work and business procedures for handling the Stafford, Perkins and MIT Technology Loan programs. Our programmers also devoted time to developing the capability to accept electronic funds transfer for families with Parent Loans to Undergraduate Students, a process that has eliminated much paperwork, and worked on the development of WebSIS.

In addition to their collaboration in setting up the Student Services Center, our staff began analyzing the tasks affected by reorganization and relocation of the FAST offices. We continue to revise the MIT student account statement to further eliminate paperwork. By promoting WebSIS on the student statement, we were able to reduce the number of student telephone and e-mail questions.

Bringing in BankBoston as MIT's student account payment lockbox provider, we were able to offer better service and more timely fund transfer to MIT accounts. We have increased the number of services that can assess charges on student accounts (such as Tether and the Copy Center), with the hope that centralized billing will result in more efficient billing and payment.

Student tuition, fees and other charges totaling \$266,549,760 were billed, (4 percent greater than last year). Servicing approximately 10,000 student accounts required 292,165 transactions to the student accounts receivable system. Income from late payment fees was \$249,074; income from finance charges was \$182,932.

There were 184 active Parent Loan Plan (PLP) accounts. A total of \$1,538,378 was disbursed during the year and \$1,624,052 in principal was collected. The PLP receivable at the end of the fiscal year was \$1,895,316.

While Jolanda Farah, Lynn Flury, Chandra Wilds, and Gerry Purdy have all left MIT, we have been joined Heather O'Brien and Neeta Purohit. Kenneth Weekes replaced Ms Farah as assistant bursar. Erin McCoy became senior office assistant; and Tina Abbott became an assistant to the bursar. Sarah Hernandez, previously assistant to the bursar in alumni services, replaced Kenneth Weekes in student services.

Carolyn Bunker

REGISTRAR'S OFFICE

The Registrar's Office promotes MIT's educational goals by collecting and disseminating enrollment, registration and graduation information; by implementing and enforcing academic and administrative policies related to these activities; by maintaining and issuing academic records for students and alumni; by developing and communicating subject, schedule and curricular information; by managing classroom space; and by publishing for these areas. The Registrar's Office works with the faculty, Institute and faculty committees, departments, staff and students to assist in developing educational policies and procedures in accordance with Institute policy and local, state and federal laws.

In 1996-97, student enrollment was 9,947, compared with 9,960 in 1995-96. There were 4,429 undergraduates (4,495 the previous year) and 5,518 graduate students (5,465 the previous year). The international student population was 2,144, representing eight percent of the undergraduate and 33 percent of the graduate populations. These students were citizens of 104 countries. (Students with permanent residence status are included with US citizens.)

There were 3,085 women students (1,749 undergraduate and 1,336 graduate), compared with 3,013 (1,705 undergraduate and 1,308 graduate) in 1995-96. In September 1996, 451 first-year women entered MIT, representing 42 percent of the freshman class of 1,074 students.

There were, as self-reported by students, 2,753 minority students (1,997 undergraduate and 756 graduate) at the Institute, compared with 2,630 (1,980 undergraduate and 650 graduate) in 1995-96. Minority students included 422 African Americans (non-Hispanic), 41 Native Americans, 564 Hispanic Americans, and 1,726 Asian Americans. The first-year class included 509 minority students, representing 47 percent of the class.

In 1996-97, the Institute awarded 1,165 bachelor's degrees, 1,414 master's degrees, 16 engineer's degrees, and 514 doctoral degrees — a total of 3,109, compared with 3,155 in 1995-96.

In addition to our normal services, over the past year our staff have:

- Collaborated with the Bursar's Office, Student Financial Aid Office and SIS in the FAST developments (see above);
- Developed and implemented communication strategy for informing students and academic departments about the new online procedures;
- Worked with the academic departments and SIS to implement the Web-based online catalog proposal form which allows faculty and staff to update subject proposals and compare past descriptions. Developed a comprehensive training program for using the form.

-
- Designed, tested and implemented with SIS a service that provides all undergraduates their schedules on the Web before registration day, thus allowing them to review scheduling issues, such as conflicts, before meeting with their advisors.
 - Worked with the dean for undergraduate education, the provost, the Committee on the Undergraduate Program, and the Faculty Policy Committee to resume the Project 2000 classroom renovation program.
 - Collaborated with faculty, Physical Plant, Undergraduate Academic Affairs, Academic Computing, Audio/Visual and the Planning Office in the design and renovation of ten classrooms in Building 2; completed design of eight classrooms in the Building E51 renovation; provided workstation and video projection in the 4-270 lecture hall.
 - Worked with faculty and Physical Plant to develop and implement a lock/unlock pilot for nine classrooms.
 - Provided a comprehensive overview of all the undergraduate degrees and possible combinations of degrees offered for the faculty Committee on Curricula; reviewed paths that a student might take to receive multiple undergraduate degrees and “automatic” minors; formalized a Committee on Curricula policy regarding the awarding of a minor and then subsequently completing a major.
 - Supported the faculty Committee on Academic Performance in implementing the new faculty regulation on the completion of incomplete designations.

Josephine Eisner retired after more than 30 years of dedicated service to the Registrar’s Office. David McNeil was promoted to analyst programmer I; Daniel Darling and Jennifer Smith were promoted to administrative assistant; Phoebe Minias, Iria Romano, and Lisa Rung were promoted to assistant registrar; and Nancy Swallow was appointed administrative assistant. Aran Parillo left his position as administrative assistant and Susan Cobb transferred to the Foreign Languages and Literatures section of the Department of Humanities. J.D. Nyhart served as acting registrar for the year and the office deeply appreciates the wisdom and support he provided. The entire staff thanks him for his many caring and thoughtful contributions.

More information about this department can be found on the Web at the following URL: <http://registrar.mit.edu/>.

Elizabeth C. Bradley, Mary R. Callahan, J.D. Nyhart, Constance C. Scribner

STUDENT FINANCIAL AID

The mission of the Student Financial Aid Office is to develop and maintain fair and equitable financial aid policies and practices that assure equal access by all students qualified for admission to MIT. Activities that advance this mission include counseling students and parents in all financial aid matters; managing grant and loan funds from outside agencies; stewarding undergraduate scholarship endowment funds; managing on- and off-campus student employment opportunities; and serving faculty and administrators on all matters pertaining to financial aid policies.

HIGHLIGHTS

The Financial Aid Office continued its involvement in reengineering. We implemented new processes to improve efficiencies when evaluating financial aid applications. A number of staff participated in the FAST developments, which are all bringing significant changes to the office.

MIT continued its participation in the Federal Direct Loan Program. Students have appreciated its simpler application and awarding process. The political issues that threatened its continuation have been resolved, and MIT will continue to use this federal loan-delivery option.

The federal process of re-authorizing the Higher Education Act began during the year, to be completed in FY98. Significantly, proposals for student aid that will have the largest effect on students across the country are part of proposed tax bills rather than the Higher Education Act. MIT participated in a number of meetings with professional organizations and congressional representatives to advocate for proposals that would benefit students and families.

Table 1. Scholarships and Grants (all figures in thousands)

(Awarded to undergraduates with need)

| Source | 1994-95 | 1995-96 | 1996-97 |
|-----------------------|---------|---------|---------|
| Pell Grants | 1,276 | 1,183 | 1,159 |
| SEO Grants | 1,903 | 1,970 | 1,913 |
| ROTC Scholarships | 770 | 601,601 | 715 |
| Scholarship Endowment | 10,854 | 12,021 | 13,269 |
| Current Gifts | 873 | 773 | 986 |
| Direct Grants | 3,071 | 3,311 | 3,160 |
| Unrestricted Funds | 16,165 | 14,965 | 12,908 |
| Total Grants Awarded | 34,912 | 34,824 | 34,110 |

Table 2. Loans

(Received by needy and non-needy students)

| Source | 1994-95 | 1995-96 | 1996-97 |
|-------------------------------------|---------|---------|---------|
| <i>Awarded to Undergraduates</i> | | | |
| Technology Loan Fund | 2,146 | 2,061 | 2,118 |
| Perkins/Nation Direct Loans | 3,767 | 4,411 | 4,315 |
| Stafford Loans to Needy Students | 8,090 | 8,642 | 8,818 |
| Stafford Loans Beyond Need | 457 | 475 | 517 |
| Other Loans to Students | 130 | 99 | 96 |
| Sub-Total | 14,590 | 15,688 | 15,864 |
| <i>Awarded to Graduate Students</i> | | | |
| Technology Loan Fund | 2,851 | 4,577 | 4,631 |
| Perkins/Nation Direct Loans | 47 | 177 | 21 |
| Stafford Loans to Needy Students | 4,954 | 5,668 | 5,325 |
| Stafford Loans Beyond Need | 2,756 | 3,562 | 3,963 |
| Other Loans to Students | 28 | 97 | 184 |
| Sub-Total | 10,636 | 14,081 | 14,124 |
| Total Loans to Student | 25,266 | 29,769 | 29,988 |

In 1997 student loans to undergraduates increased by only 1 percent and loans to graduate students did not change. The relatively small change is largely the result of unchanged annual limits on federal loans and the moderating need for financial aid in general.

Table 3. Parent Loans

| Source | 1994-95 | 1995-96 | 1996-97 |
|------------------------------------|---------|---------|---------|
| Federal Parent Loan | 2,337 | 2,421 | 2,966 |
| MIT Parent Loan Plan | 1,755 | 1,515 | 1,550 |
| Mass. Ed. Finance Authority (MEFA) | 999 | 1,889 | 2,104 |
| Other Parent Loans | 189 | 113 | 51 |
| Total Loans to Parents | 5,280 | 5,938 | 6,671 |

Parent loans increased at 12 percent each year since 1994-95. The largest increase has come from participation in the Massachusetts Education Financing Authority's Mass-Plan Loan Program. These loans provides support at very favorable rates to parents from all over the country for students studying in Massachusetts .

STUDENT EMPLOYMENT

The off-campus job market was clearly favorable for MIT students. Together with on-campus jobs, there were more than enough offerings. High-end jobs were on the rise and there was a decline in clerical positions; employers are seeking more technical and engineering skills.

2,880 undergraduate students worked on campus earning \$5,671,771 in 1995-96. The MIT student minimum wage was increased to \$7.25 as of June 1, 1996 (not including UROP). This is the first increase since June 1991.

The College Work- Study Program allocation remained about the same as last year; one third subsidizing work done by undergraduates and two thirds subsidizing graduate student teaching assistantships.

The Higher Education Act of 1965, as amended, and the regulations of November 30, 1994, require that each institution participating in the Federal College Work Study Program (FWS) beginning July 1, 1994, must spend at least 5 percent of its FWS allocation to compensate students employed in community service activities. In the second year of this program, the participation has doubled. Now more than one hundred students are using their skills to enhance the lives of others. The Student Employment Office (SEO) has been working on a large grant proposal that has the potential for bearing fruit next year.

The SEO designed a state-of-the-art Web site. Jobs are posted to the Web daily; students can also sign up for the "On Call" lists online. Now students can browse through the job listings at their leisure, selecting topics of interest. The SEO site was touted at the National Student Employment convention as a model for others who were designing sites.

STAFF CHANGES

Donna Kendall resigned as associate director to take a position at Bentley College. Lisa Wright resigned from her position as network coordinator and administrator to move with her family to Pennsylvania.

More Information about the Office of Student Financial Aid and the Office of Student Employment can be found on the Web at the following URLs: <http://web.mit.edu/finaid/> and <http://web.mit.edu/seo/> respectively.

Stanley Hudson

STUDENT INFORMATION SYSTEMS

The mission of the Student Information System Department (SIS) is to provide timely and accurate information services to a wide variety of users, through the automation of business processes and information systems. The business processes it supports are: student records; financial aid and bursary services; and dorm, dining, medical, classroom and event scheduling.

Now a part of UESA, the department had new responsibilities stewarding information technology for this expanded office. The work of our staff was critical in the many successful projects discussed in the transition and Financial and Academic Services Transition sections of this report, specifically, the Student Services Center pilot, the development and implementation of Web-based preregistration, online graduate awards and appointments, and WebSIS. In addition, our staff have been working with MIT Information Systems to upgrade desktop computing throughout UESA. They also work with the MITSIS administrative users steering committee which formed to provide SIS assistance in setting priorities and planning.

SIS also began a major effort to use new technology to improve the ways it provides new functionality to users. This involves a cross-organizational team of information technology professionals from within MIT. Expert consultants help the project team with product knowledge and methodology guidance.

This year SIS finally reached its staffing goals. After a challenging and lengthy search we were able to add three highly skilled and experienced analyst/programmers to the department: Roberta Crumrine, Kevin Kelleher and Virginia Tulloch. We met our short term needs with consultants. This combination of MIT personnel and outside assistance created a highly skilled and responsive development team that continued to provide a high level of system maintenance and development support.

More information about this department can be found on the Web at the following URL: <http://web.mit.edu/isis/>.

Robert A. Rippondi

UNDERGRADUATE ACADEMIC AFFAIRS

Undergraduate Academic Affairs (UAA) introduces freshmen and transfer students to MIT academics and supports the interdisciplinary aspects of MIT undergraduate education. This year saw many changes within UAA. Foremost was the retirement on October 1, 1996, of Professor Travis R. Merritt, dean of undergraduate academic affairs, after years of exemplary service to the MIT community.

Dean Merritt was replaced by a new dean for undergraduate curriculum. When Professor Kip Hodges assumed this position on January 15, 1997, he reorganized UAA to create a more collaborative environment. The key elements of this design are virtual offices that encompass like processes. They are "virtual" in the sense that they do not correspond to physical offices staffed by a specific group of administrators. In fact, many UAA staff members work in more than one virtual office. The virtual offices are: the Office of Academic Information; the Office of Curriculum Development and Faculty Support; the Teaching and Learning Laboratory; and the Undergraduate Academic Resources Center. In addition, two activities demand not only the time of many UAA staff members but that of other offices as well. These are the Independent Activities Period (IAP) and Residence/Orientation Week (R/O). To support these, UAA has established two seasonal task forces.

OFFICE OF ACADEMIC INFORMATION

The Office of Academic Information was established in the spring of 1997 to provide students with academic information resources. Many of its first efforts are directed at incoming freshman. For example, it has placed the Freshman Handbook and R/O information online. The office is working with the IAP Task Force to automate IAP registration and other IAP administration. All of these activities are part of the goal to develop a comprehensive "academic navigator" Web site that will provide students, faculty and staff with a wide variety of academic information.

OFFICE OF CURRICULUM DEVELOPMENT AND FACULTY SUPPORT

The OCDFS supports curricular change throughout the Institute. It provides staff support to faculty committees; nurtures new projects that ultimately find a home in academic departments; and promotes communication among faculty in different departments. It also encourages dialogue among faculty, students and staff for improving academic policies and curricula.

Over the past year, supporting the Committee on the Undergraduate Program, and the Committee on the Writing Requirement, the office has helped the faculty take initial steps for replacing the proficiency-based writing requirement with a more substantial experience-based curriculum. Recognizing the merits of this initiative, the National Science Foundation awarded MIT a two-year grant of \$200,000 to support its development.

UAA administers the Class of 1951 Fund for Excellence in Education and the Class of 1955 Fund for Excellence in Teaching. These funds are a source of generous faculty support for curriculum development activities. From the many proposals it received this year, the program awarded nearly \$70,000 for projects in the coming year. This year the Class of 1972 created a new fund for Educational Innovation.

Following extensive discussions with faculty and students, the Curriculum Development Program has assumed responsibility for administration of the subject evaluation system. The new system will return one-page summaries to departments and faculty shortly after the end of term. The office provides evaluation results to students so they can produce their own subject evaluation guides.

A major focus of curriculum development is coordination of the undergraduate science core. It collects science-core syllabi, quiz schedules, and enrollment and end-of-term grades information, and distributes these materials to core lecturers and related support offices. It also sponsors meetings among science core instructors. This year, Professor Arthur Steinberg used half of each session to lead a provocative and lively debate on topics related to teaching freshmen.

UAA assists faculty members and faculty committees in academic policy making and policy enforcement. The office provides staff support to the Committee on the Undergraduate Program (CUP), Committee on the Writing Requirement, the Committee on Academic Performance (CAP), and the IAP Policy Committee. UAA staff are ex-officio members of the CAP, the Committee on Discipline (COD), the Committee on Curricula, and the Committee

on Undergraduate Admissions and Financial Aid. In addition, many UAA staff members advocate on students' behalf before the COD and the CAP. Our staff has played a major role in facilitating re-establishment of the Committee on the First Year Program, a subcommittee of the CUP.

Environmental and internal organizational changes occurring in recent years have created an intense demand for more information about our students. One of the most important mechanisms for gathering information is the Educational Studies Working Group (ESWG). Convened by Alberta Lipson and Norma McGavern of UAA, the ESGW brings together people from many parts of the Institute who share an interest in educational studies. During the 1996-97 academic year, the ESGW's:

- Surveyed sophomores about their attitudes toward freshman year core subjects;
- Wrote a report about student attitudes toward freshman advising, based on data from the 1995 freshman survey;
- Electronically surveyed students who had taken 8.01 and 8.02;
- Conducted the yearly Interphase student assessment surveys;
- Helped set up the '97 IAP Activity Leader database and compiled '97 IAP Activity Leader statistics
- Participated in developing the new subject/teacher evaluation form;
- Worked with the Admissions Office in analyzing the Undergraduate Admissions Reply Form;
- Assisted other studies by administrative staff.

The Office of Curriculum Development and Faculty Support oversees the Undergraduate Research Opportunities Program (UROP). A major goal of the UROP program this year was to turn the CUP's recommendation for \$10 million of new funding into action. A significant step was taken toward this goal by the establishment of a Paul Gray Endowment Fund for UROP. At a gala celebration in honor of Dr. Gray on May 17, it was announced that the fund had already raised \$2.4 million. Contributions to the UROP endowment fund are up by 35 percent, and several new UROP funds have been established.

Despite these successes, UROP continues to feel financial pressures. UROP's hourly pay rate rose from \$7 to \$7.50 an hour.; consequently, fewer students were awarded direct UROP funds this year. Overall academic year participation in UROP was up modestly (3 percent) from the previous year: 740 students worked for credit, and 1,444 worked for pay. An extensive Web site for UROP was redesigned this year (URL <http://Web.mit.edu/urop>). The redesign has eliminated the need for an annual hard copy publication, but a biennial UROP Directory for 1997-1999 is in its final production stage and will be ready for distribution before R/O Week in the fall.

The yearly Pre-Calculus Math Diagnostic has become a valuable tool in evaluating the high school math backgrounds of our students and providing students and their advisors with guidance about physics and math subject selection. In addition, the program administers the Freshman Essay Evaluation to entering freshmen and transfer students.

UAA is the temporary home of the Writing Initiative, a pilot project jointly funded by the School of Engineering and the School of Humanities and Social Science. Under the leadership of Dean Williams, the faculty director, the Writing Initiative has developed several instructional models that have already been incorporated in the preliminary design of the new communication requirement. Dean Leslie Perelman, co-director of the initiative, is responsible for recruiting, training and supervising graduate writing fellows, working with faculty to develop new six-unit companion writing subjects, and administering the program.

The Writing Requirement Office continues to administer and coordinate the two phases of the current MIT writing requirement. Both Phase One paper submissions and enrollments in Phase One writing subjects increased substantially from previous years. 319 students completed the requirement by submitting papers. Another 425 students completed Phase One through subjects offered by the Program in Writing and Humanistic Studies and the English as a Second Language Program in Foreign Languages and Literatures. An additional 89 students completed Phase One writing subjects even though they had already satisfied Phase One. These increases are largely attributable to the CWR's decision in August 1996 to raise the level of proficiency necessary for passing the essay evaluation, and the increase in the number of students enrolling in writing subjects as a prerequisite for admission to medical school.

Of the students receiving the S.B. degree during the 1996-97 academic year, 45 percent satisfied Phase One through the Freshman Essay Evaluation or College Board Tests, 18 percent by submitting a Phase One paper, and 37 percent through a Phase One writing subject. For Phase Two, 43 percent completed the requirement through the Undergraduate Technical Writing Cooperative, 29 percent by submitting a paper to their departmental writing coordinator, and 28 percent by receiving a grade of B or better in a Phase Two writing subject. Unfortunately, two seniors failed to graduate solely because of the writing requirement. Both of these students are currently working on completing the requirement for graduation on the September 1997 S.B. degree list.

TEACHING AND LEARNING LABORATORY

Growing out of the Teaching Resource Network (TRN), the Teaching and Learning Laboratory will expand TRN activities, undertake innovative programs and launch major research efforts. The laboratory's goals are to improve teaching at MIT, and to contribute to an understanding of the process of learning in the sciences and engineering. Its Web site is <http://Web.mit.edu/uaa/www/trn/index.html>.

The laboratory organized fall orientation for MIT's new faculty and graduate teaching assistants, expanding it from one to three days to deepen discussions of teaching issues and add new topics. The laboratory also participated in several department-based workshops on improving teaching. In addition, the IAP series "Better Teaching @ MIT" offered eight interactive workshops attended by a record of almost 500 faculty, graduate students and undergraduates.

One of the dominant trends in engineering education is the use of team-based and active learning techniques. With grants from the Class of 1951 Fund for Excellence in Education and Class of 1955 Fund for Excellence in Teaching, the laboratory's director, Professor Mary Boyce, developed a curriculum for the course "Mechanics of Materials II" (2.002). Innovations included the development of a Shoe-Box of Experiments, the creation of a teamwork workshop and manual, the use of graduate student facilitators, and the design of team-based, open-ended laboratories.

In 1995, EECS alumnus Stephen Kaufman pledged \$500,000 to build a classroom equipped to videotape instructors as a way to help them improve their teaching. Scheduled to open in January 1998, the Kaufman Classroom will allow the laboratory to expand its Classroom Videotape and Consultation Program. In 1996-97, the program videotaped 65 faculty and other teaching staff (principally graduate student TAs). Laboratory staff have received excellent feedback on the program from those who participated. With the opening of the Kaufman Classroom, both the quantity and quality of taping will increase dramatically.

UNDERGRADUATE ACADEMIC RESOURCES CENTER

The Undergraduate Academic Resources Center provides support for the freshman program. It manages R/O, the freshman advisory program, study skills sessions, and choice of major presentations. It also provides academic information and advice to students at all levels. Center staff are working on the development of an Academic Information Center/Educational Support Office that will integrate staff and services from outside the current UAA.

The Class of 2000 was advised primarily through the highly successful Freshman Advising Seminar (FAS) system. The number of seminars remained at 125; accommodating almost every freshman who was interested. Only 11 percent of freshmen were advised by 29 non-seminar based advisors. The program's advisors included 98 faculty members, 16 non-faculty teaching staff, 14 researchers, 41 administrators (including six deans), and 2 graduate students, assisted by 209 associate advisors. The findings of the Committee on the Undergraduate Program Subcommittee on Freshman Advising support the current mixed system of FAS and non-seminar advising. The subcommittee also recognized the continuing difficulty that center staff have getting enough faculty to serve as FAS leaders, and recommended additional recruiting help, perhaps through monetary incentives.

During the 1996-97 academic year, the Associate Advising Steering Committee recruited and trained associate advisors; named three students Outstanding Associate Advisors; participated in bi-monthly study skills sessions; and held three "Choice of Majors" presentations, a "Choice of Majors" fair, and an "Ask An Alum" meeting.

This was the second year in which freshmen performing at non-passing level, and their advisors, received Fifth Week Flags in the form of e-mail messages or letters from their instructors encouraging students to meet with them. Center staff are continuing efforts to automate and expand the flag system.

Undesignated sophomores are at particular risk in the MIT educational system; without commitments to specific academic departments, they receive relatively little attention. The Center strongly encourages students to choose majors, assuring them that they can change departments later. Nonetheless, 39 sophomores began fall term as undesignated. By the end of the fall term, that number had come down to 26; by the end of the spring term 8 students still had not selected a major.

The number of incoming transfer students continues to decrease. Twenty-five transfers accepted admission in the fall, four in February. In the fall four transfers exercised the pass/no record option for the science core; two transfers exercised it in the spring.

In the fall, 65 Wellesley students registered for 73 subjects at MIT; in the spring 121 Wellesley students took 140 MIT subjects. During fall and spring semesters 113 MIT students took 119 Wellesley subjects; 89 of those took Religion 108 taught at MIT as a HASS Distribution subject.

ORIENTATION TASK FORCE

R/O was directed successfully under the leadership of two student interns: Erica Fuchs, publicity and personnel manager, and Judie Kim, logistics manager. They were supported by 39 student volunteers. Professor Mario Molina and President Vest spoke at the R/O convocation, followed by a new program, "Tech Trek," and "survival skits" designed to introduce residence selection. Parents Orientation was augmented by the addition of several new open houses. The traditional President's Reception at Walker Memorial was widely attended.

IAP TASK FORCE

This year, over 787 classes were scheduled during IAP, a significant increase over the 700 courses offered last year. IAP '97 brought about 1,500 undergraduate and 832 graduate students back to campus during January. The number of courses offered for academic credit (83 in 1997) continues to increase. The IAP Student Board introduced an "IAP Expo" in November, giving the MIT community a chance to preview some upcoming IAP activities. In the tradition of previous years, the fifth annual Charm School educated students and their elders in etiquette. The now-legendary commencement ceremony featured a rousing speech by President Vest and a rendition of the Charm School Alma Mater sung by the Chorollaries. It is estimated that Charm School '97 was attended by 400-500 students; 143 earned degrees in Charm, including 65 Ph.D.s.

Kip V. Hodges

ADMISSIONS OFFICE

The mission of the Admissions Office is to attract undergraduate applicants from the broadest socioeconomic and international backgrounds whose academic and personal accomplishments and promise meet the expectations of the MIT faculty; to convey an authentic image of MIT to the public; to coordinate the admission of graduate students; and to provide perspective on demographic and secondary school curricular changes.

Normally, our admissions activities are dominated by outreach efforts. This year, however, the primary work of the Admissions Office was internal: We began the year with a 40 percent turnover of office staff due to early retirement, job changes and death. Last summer we examined our four databases as a prelude to student services reengineering. In November we ran the Graduate Admissions Redesign Team that led to recommendations for redesigning the graduate admissions database. Between these activities, the training of new staff members, and participation in other reengineering efforts, we had little time for our usual activities.

As a result, freshman applications were down 2 percent to 7,836, although this is still the third highest figure ever. The percentage of females in the entering class dropped to 38 percent from 42 percent; the percentage of enrolling minority students went down slightly to 17 percent from last year's high of 18 percent, with lower numbers of African and Mexican Americans enrolling, but a higher number of Native Americans and Puerto Ricans. On the positive side, however, we did a better job of identifying, recruiting, admitting and enrolling "academic superstars," with 54 percent enrolling in this year's entering class. Overall, our total yield of 56 percent, combined with an admissions rate of 24 percent, makes this the second most selective year in our history.

This year we have developed an electronic presence that offers applicants a choice of application venues. Currently, students can apply through a downloadable Web application provided by CollegeEdge and located on the MIT homepage, or with a floppy disk version of our application provided by College Link. Soon we will have a paperless version available as well. We are also underwriting the production of a "virtual reality tour" of MIT accessible through the MIT homepage. Designed by two MIT graduate students in conjunction with the Publishing Services Bureau, the tour is one of only three in the world with ours being the first fully interactive site.

We finished the year developing a new, comprehensive recruitment plan for next cycle. As part of this plan, the admissions staff is developing closer ties with the other offices, including especially the Student Financial Aid Office. We are also strengthening links to our most closely affiliated clientele, magnet high schools, and have begun the Admissions Office beautification efforts which we hope will give our visitors a more favorable impression. Improved recruitment efforts targeting women and minority students have begun, as well as those designed for "academic superstars."

On a sad note, we recently had a leadership change with the departure of Michael Behnke, who has taken a vice president position at the University of Chicago. During his 11 years as director of admissions, he brought a high level of professionalism to MIT admissions. While we will miss him, he has left us in a strong position to continue our successes at attracting and enrolling the best students in America.

More information about the Admissions Office can be found on the Web at the following URL:
<http://web.mit.edu/admissions/www/>.

Marilee Jones

EDUCATIONAL COUNCIL

The Educational Council comprised 1797 alumni this past year, representing MIT in all 50 states, the District of Columbia, Puerto Rico, the Virgin Islands, and 47 foreign countries. The group included 370 women and 58 minorities (37 Blacks, 9 Puerto Ricans, 11 Mexican-Americans, and 1 Native American). Educational counselors conducted 6859 admissions interviews, and held countless conversations with prospective MIT students and with local school personnel. Of all MIT applicants who were eligible for an interview, 87 percent were interviewed by a local educational counselor.

We continued our reduced presence in local college fairs. Educational counselors attended fewer than twenty college fairs. Although the Admissions Office uses a direct contact approach to develop an applicant pool, some counselors feel that it is worth attending the college fairs of certain schools. We support those who choose to attend.

MIT Open House Meetings were held throughout the United States in the fall. Local educational council members assisted members of the admissions staff in arranging 111 central meetings in 96 cities. Attendance at central meetings continues to be strong at many locations because of the invitation layout and our use of a direct mail service to handle invitation production and mailing.

Educational council groups held meetings for newly admitted students in 41 cities throughout the United States. Twenty-seven of these meetings were held during MIT's spring break. Kathy Breland organized panels of current students to speak at each meeting. Dianne Goldin from Resource Development assisted in arranging the meeting at the MIT Faculty Club. We appreciate Goldin's enthusiasm and involvement in this important endeavor.

The MIT admissions videotape continues to be popular. Requests have come from 59 high schools, three colleges, 11 educational counselors, 34 prospective students, five MIT offices, and one current MIT student. We have sold fifteen copies.

The MIT Alumni Award program is in its seventh year. The award, given to high school juniors for outstanding achievements, especially in areas of math and science, was sponsored by three alumni this year. MIT alumni and MIT alumni clubs can sponsor an award for \$25. The award winners receive a certificate in a leather MIT case and a

year's subscription to *Technology Review*. Next year, we plan to publicize the award to increase alumni participation.

Two personnel changes should be noted: Brian Ellis was promoted to assistant broker for the Publishing Services Bureau. Brian formerly served as administrative assistant for the Educational Council. Daniel Terminello recently joined the Educational Council office as administrative assistant.

More information about the Educational Council can be found on the Web at the following URL:
<http://web.mit.edu/admissions/www/educoun/index.html>

Vincent W. James

CAREER SERVICES AND PREPROFESSIONAL ADVISING

The mission of the Office of Career Services and Preprofessional Advising is to help students and graduates develop the career-related expertise they need to achieve their professional goals. The office provides comprehensive resources to enable this process, and it integrates career development into the academic mission of the Institute, working collaboratively with academic deans, faculty and administrators.

This has been a watershed year for the office, requiring that a skeleton crew survive the “four R’s”— retirement, reengineering, reorganization and reduced staff — with resources already stretched thin by the highest level of demand and activity in our history. Against this backdrop, the office implemented major changes including expanded programming, more proactive marketing of services, new or enhanced collaboration with academic and administrative departments, and broader use of technology.

As part of Institute-wide reengineering, the Career Assistance Redesign Team, composed of students, staff and faculty, created recommendations to meet our customers' changing needs for career assistance. The team conducted best practice research, compiled survey information and held community meetings. A high point of the effort was the increased Institute-wide recognition of the importance of career services. In January the team presented its recommendations: The bottom-line message, cited as a prerequisite for any enhancement of current services, was the critical need for additional staff.

ON-CAMPUS RECRUITING

The most visible sign of the increased activity in the Career Services Office was the on-campus recruiting program. This year 2031 students participated in the office's on-campus recruiting program. This number included 1187 undergraduates (including pre-seniors interviewing for summer positions), 567 master's candidates, 257 doctoral candidates and 20 postdocs. For the fourth consecutive year, the market for new graduates was literally record-breaking, as evidenced by the number of employers recruiting on-campus— 715 compared to last year's high of 637. The fact that we are nearly fully booked for the fall semester makes it obvious that this number will increase again next year.

Demand continued to be strongest for students in computer engineering and computer science. They were recruited by every sector of the economy, from firms producing computer equipment and software, their customers in every industry who put it to use, and to consultants paid to help them. Whether growing or downsizing, employers vied for the new graduates who could help them compete by making optimum use of information technology. There simply were not enough computer engineering or computer science students to fill employers' schedules.

While the demand for hardware skills did not match the demand for software skills, it was also a sellers' market for electrical engineers. Many of the opportunities have been in the area of communications for such products as wide area and local area networks, modems, video systems, wireless systems, and file server architectures. The market for mechanical engineers was also strong, with some major firms, including Boeing and Lockheed Martin, returning to MIT after several years of diminished on-campus recruiting.

INITIATIVES

The office launched new initiatives and improved existing programs improved in an effort to reach a broader range of students, connect with academic and administrative departments, and create more opportunities for students to learn career development skills. Changes included more workshops to instruct students on interviewing and writing CV's and resumes, participation in career fairs, a program on study abroad and work abroad in collaboration with the MIT-Japan, -China and-Germany programs (attended by more than 70 undergraduates), career panels by alumni and the office's first Academic Administrators' Open House. Two already popular programs for the School of Architecture and Planning, the Architecture Firm Open House and the Department of Urban Studies and Planning Alumni Career Forums, were expanded to involve alumni and other practitioners in student career advising.

While the Internet and the Web have not replaced on-campus recruiting as some predicted, this year the office took important steps to make most of our paper systems readily accessible to students on the Web. Efforts include contracting with Jobtrak, an online job database. The office has also researched a software that would enable students to register for and schedule their on-campus interviews electronically, and make it possible for recruiting organizations to advertise their recruiting visits online.

The office continued to offer programs targeted especially to three constituencies while planning for significantly enhanced programs for these groups in the near future: graduate students, engineering students seeking guidance in finding "non-engineering" jobs where they can use more than just technical skills, and Ph.D.s who are turning to the office for assistance in exploring nonacademic options. During IAP the office hosted a series of talks on "Opportunities for Ph.D.s Outside the Laboratory," mainly by MIT alumni, on fields including management consulting, investment banking, environmental consulting, intellectual property, and policy analysis. This spring, with the help of an MIT alumna who helped organize the series, we sponsored "A Brief Introduction to Business for Graduate Students and Postdocs" with talks by members of the Sloan School faculty. Staff also met with members of the Graduate Student Council to discuss ways we can market our services more effectively to graduate students and to seek their input on topics for future seminars.

In response to the perception that students get "lost in the crowd" on busy recruiting days, the office piloted a peer advisors program, hiring students to greet and assist our customers as they enter the front door. This was well received and we hope continue it this year. Through a new corporate luncheon series, administrative staff enhanced their professional development as they learned about specific industries and companies.

In an effort to increase the rate of return on the "post-graduation questionnaire" we send to graduating students, staff collaborated with the Alumni Association and the Planning Office. The three offices revamped the questionnaire, and designed a strategy to administer it and follow up on it. A stronger survey response will enable us to better respond to those inside and outside MIT who need information about the deployment of MIT graduates in the economy.

MEDICAL SCHOOL

The office was almost as busy this year working with students and alumni interested in medicine as it was welcoming employers. Nationally, the medical school applicant pool rose from a total number of 46,591 applicants in 1995-96 to a total of 46,968 in 1996-97. While the numbers have continued to rise, the increase is considerably less than in previous years. The extraordinary interest in medicine has not coincided with an increase in places available. Consequently, gaining admission has become more difficult and stronger credentials are now needed for acceptance.

MIT remains an excellent choice for premedical studies and, despite higher criteria for acceptance, our students continue to do exceptionally well. In 1996 there was a total of 213 MIT applicants, compared with only 99 in 1988. This past year, 117 seniors applied to medical school and 71 percent gained admission. The number of alumni applicants has doubled since 1988 and nearly tripled since 1986; this year 85 MIT alumni applied to medical school. In 1996 the overall rate of acceptance of MIT applicants and re-applicants was 62 percent.

STAFF CHANGES

The most profound change was Robert Weatherall's retirement in June 1996. Beside directing the office for the past 26 years, Bob did much of the one-on-one advising of students interested in engineering, computer science, the

physical sciences, finance, and engineering. It has been impossible to fill his shoes. In addition, Ann Davis Shaw, an associate director in OCS for eleven years, left in July to join the Office of Minority Education as assistant dean.

More information about this department can be found on the Web at the following URL:
<http://web.mit.edu/career/www/>.

Elizabeth A. Reed

COUNSELING AND SUPPORT SERVICES

The mission of Counseling and Support Services is to provide personal counseling to all students in a highly competitive and stressful environment. Such counseling will seek to dignify each individual student in his or her efforts to learn within both academic and personal contexts. Personal support includes counseling students on a range of issues, including academic, psychological, interpersonal, financial, and even career matters.

1996-97 proved to be an extremely demanding year. A number of students experienced psychiatric crises or severely disruptive personal issues; many lived in campus housing and several ultimately required hospitalizations. After the previous year's suicide, many members of this community were justifiably anxious about students who appeared to be at risk. This heightened awareness enabled CSS and mental health staff to identify individuals who may have not made an effort on their own to seek assistance. Voluntary withdrawals because of medical and deeply disturbing personal issues also increased. The counseling deans teamed with mental health staff and other parts of MIT Medical, as well as with MIT faculty, house masters, student family members, campus police, chaplains and hospital staff to meet the needs and requests of students and other people within our community. Nightline and Contact Line, the MIT's two peer hot lines, continued to receive supervision and support from staff members in this office. CSS also presented workshops, training sessions, and small group sessions to address student and staff needs.

The office also devoted a strong effort to working with the Committee on Academic Performance (CAP) and helping the committee to review matters where academic and personal concerns intersected. Counseling and Support Services coordinated a meeting with CAP and MIT Medical. Dr. Mark Goldstein and Dr. Peter Reich were invited to speak with the CAP about medical policies and procedures, particular examples of confidentiality and the unique relationship that MIT Medical shares with counseling deans. This was an informative and productive discussion that helped committee members to gain a better understanding of how and why certain sensitive information is conveyed from Institute medical professionals to CSS. It was also an opportunity to address relevant CAP policy issues and to refine the overall process.

CSS continued to work closely with the CAP on matters concerned with readmissions, learning disabilities, medical conditions, and voluntary and involuntary withdrawals. CAP Chairman Dan Nyhart remarked at the conclusion of the final CAP meeting that he believed CSS efforts with faculty advisors had measurably improved and facilitated the committee's deliberative process.

Richard Goldhammer, learning disabilities specialist, is currently assisting 39 MIT students who have documented learning disabilities. He has been exceptionally effective since assuming this position — only one of these students is on academic warning. The office continued to collaborate with Disabilities Coordinator Barbara Roberts and assisted with areas that concerned academic issues, transportation problems and parental concerns. Ayida Mthembu initiated a "Problems of test-taking" group consisting of student development administrators, faculty and mental health professionals.

Lynn Roberson's work with women students continued to expand. She advised or facilitated activities with Mujeres Latinas, Color Creations, and the Graduate Women's Support Group. She and Kim McGlothlin advised the Freshmen Women's Group. Lynn also collaborated with Margot Tyler of the graduate office and facilitated a group for "30-something" graduate students. Ayida Mthembu coordinated the annual Black Women's Brunch and a Latina Brunch. She also was involved with the planning and organization of the Women of Color Writers Series (October through April). CSS staff presented workshops on rape awareness prevention, working with advisors, adoption and self-esteem.

Lynn Roberson, who ably served as the primary office contact during the past year, and Dean Henderson continued to represent CSS on the Gay, Lesbian, Bisexual and Transgender Issues Committee.

The office was active in the “Meeting of the Minds” sessions at New House and worked to broaden outreach to students in that living group. The office supported Kwanza, Black History Month and Hispanic Month activities. Jacqueline Simonis conducted training and discussion sessions with department administrators. The office conducted awards selection for the Institute-wide Dr. Martin Luther King Celebration. Nightline peer counselors met with Dean Henderson to discuss the effect of race, ethnicity, gender on counseling. Dean Henderson participated in the campus Holocaust Memorial. LUCHA invited counseling deans to attend meetings and present information. Ayida Mthembu continued her work with the Campus Race Relations Committee.

Associate Dean Arnold R. Henderson, Jr., succeeded Jacqueline Simonis as CSS section head, freeing Associate Dean Simonis to undertake an extensive Institute-wide assessment of personal support services for students. Ayida Mthembu was promoted to associate dean. Lynn Roberson was promoted to program administrator for women students. Rachel Pilla was promoted to senior office assistant. After more than nine years of dedicated and exemplary service, Heather Trickett, assistant to the dean, left the Institute in March to pursue new professional goals.

Arnold R. Henderson, Jr., Jacqueline R. Simonis

OFFICE OF MINORITY EDUCATION

The mission of the Office of Minority Education is to provide effective academic enrichment programs to enhance matriculation, promote higher retention and excellence in underrepresented minority (African American, Mexican American, Native American and Puerto Rican/Hispanic) students’ academic and general educational achievements, and to encourage their pursuit of higher degrees and professional careers. OME’s mission embraces a strategy to address academic and graduation gaps between underrepresented minority and non-minority students at MIT.

Project Interphase is a rigorous eight-week academic program that covers physics, calculus, chemistry, writing, physical education and a myriad of co-curricular activities. Admitted students enroll in the program prior to their first year at MIT; this year Project Interphase enrolled one-third of the admitted underrepresented minority students who decided to attend MIT, a total of 59 students. The ethnic and gender profiles were consistent with previous years, and also closely reflected the minority freshmen class of 2000. 42 percent were African Americans, 28 percent Mexican Americans, and 22 percent Puerto Ricans. This is a slight drop in overall participation of Latino students. Native American and other Hispanic students remain the lowest represented group. This year’s program realized a drop in the number of women participants. Women represented 32 percent, an 8 percent drop from previous years.

Project Interphase continues to develop ways to improve and prepare students for the fall term and beyond. Twenty-one participants, 35 percent of 59 students, received advance placement credit for 18.01. In writing, students were referred to the Writing Center and encouraged to complete Phase I of MIT’s writing requirement. As a result, the writing component experienced the highest number of students, 34 participants or 57 percent of 59, passed Phase I. These positive outcomes reinforce the worth and success of the program.

This year, Program XL continued to be an effective academic enrichment program for first-year underrepresented minority and non-minority students. Participants were divided into small interactive study groups around core subjects. These groups met twice a week both semesters. All study groups were coordinated by XL facilitators, who are upperclass and graduate students from a broad range of ethnic backgrounds. The participation of the Class of 2000 during the 1996-97 academic year was consistent with previous years. 109 students participated in the XL Program in over 27 study groups--68 students in the fall, 41 in the spring. 55 students (80 percent) completed the fall program, 28 (70 percent) the spring.

The Tutorial Service Room continues to provide academic support to a significant number of underrepresented minority and non-minority students. The number of student users grew as the result of better marketing. Last year, the TSR provided academic support to 724 students, for a total of 2,427 service hours. Freshmen and sophomores

continue to represent the majority TSR users. The number of women using the TSR has increased over the last three years. At present, they account for 58 percent of the TSR users. Male use of the TSR has declined over the same period. The OME employed over 118 tutors from an array of ethnic backgrounds and disciplines, and offered tutoring help in over fifty subjects.

For over 25 years, the Second Summer Program has balanced MIT's academic sagacity in an array of engineering and science disciplines. SSP enriches and supports students' intellectual growth while assisting them to develop a keen sense of their professional possibilities. Program interns explore fields of interest, while making real contributions in their assigned workplace. This year, SSP's 42 participants were divided into teams, and each team was required to design and build a device for an urban school playground or a household. Teams present their products at an engineering design competition. Through the support and direction of Professor Alex Slocum of the Department of Mechanical Engineering, the program's academic officer, the winning team's product was circulated to various companies for further development.

After completing the SSP Engineering Design Workshop, participants entered an intensive interviewing process with companies that are members of the OME's Industrial Advisory Council for Minority Education (IACME). Nineteen students were placed with 11 companies in engineering intern positions. MIT faculty continue to strengthen its partnership with the OME/SSP by volunteering to visit interns on-site. Faculty and administrators will visit 19 students during the summer months and will report on the students' experiences.

The purpose of the Industrial Advisory Council for Minority Education is to help ensure greater retention and higher academic achievement of MIT's underrepresented minority students. To that end, members of IACME provide financial support to enhance the OME's academic and professional development programs that assist our professional student organizations: AISES (American Indian Science and Engineering Society), NSBE (National Society of Black Engineers) and SHPE (Society of Hispanic Professional Engineers). This year, the OME contributed over \$9,000 to professional and cultural organizations.

During the academic year, members of IACME took a leadership role in discussing a variety of issues that impact the academic success of underrepresented minority students at MIT. Several members were concerned about UROP opportunities for underrepresented minority students as well as their experience in various departments during their sophomore year. These discussions culminated in a town meeting held with President Charles M. Vest. The meeting was extremely successful, and it provided Dr. Vest with feedback from private industry on some of the issues regarding minority education at MIT.

The primary aim of Secrets and Strategies for Academic Success is to expose underrepresented minority students to the Institute's network of academic and support services. This year, coordinators of the SSAS program observed a significant increase in participation by underrepresented minority students in both the fall and spring sessions. The topics presented were: "Time Management," "Ways to Develop Effective Study Skills," "How to Choose a Major," "Planning for Graduate School," and "How to Succeed at MIT." Overall, the SSAS Program had an outstanding year.

The Office of Minority Education Student Advisory Council provides a mechanism for minority students to bring their concerns to the director of the OME. OMESAC's membership consists of a cross-section of underrepresented minority students' professional and social organizations. This year OMESAC forged new grounds in working with Campus Activities Complex and Residence and Campus Activities to ensure that minority student organizations were aware of the new Metal Detector Policy. It assisted organizations in planning and staffing campus parties. The council also heightened minority students' awareness of the meaning of creating a sense of community by working together on major projects that benefited the minority community.

The OME continues to be a repository for information for internships and scholarships that target underrepresented minority students. This year, the OME facilitated partial and full scholarship support for over thirty minority students, with amounts ranging from \$1,000 to \$26,000 to be applied to tuition, room and board, fees and books.

In collaboration with Counseling and Support Services, the Office of Career Services and Preprofessional Advising, the Graduate Education Office, and the Office of the President, the Office of Minority Education held its twentieth

annual Minority Awards Banquet at the end of 1996-97 academic year. Over two hundred faculty, administrators, staff and students attended to recognize the achievements and accomplishments of MIT minority students. Graduate and undergraduate students received academic and community service awards for their contributions for improving the quality of life for minority students at MIT. Associate Provost Philip Clay presented the undergraduate academic awards.

Assistant Director Ruben Morfin-Ramirez left the office to pursue a master's degree. The search committee for the assistant director of the Office of Minority Education, chaired by Professor Wesley Harris, completed its process and submitted final report on May 16. The committee was unable to recommend finalists for the position. Milagros M. Oquenda-Morales joined the office as senior office assistant.

Leo Osgood, Jr.

CAMPUS ACTIVITIES COMPLEX

In keeping with the mission of the department, during the past year the Campus Activities Complex (CAC) provided event planning, support and supervision for over 12,500 events with a combined attendance of approximately 345,000. Major events included the dedication of the Rosalind Denny Lewis Music Library, the New England Board of Higher Education conference, the annual Whitehead Symposium, the North American Power Symposium, the Biotech Symposium, the Wet Ice conference, Spring Weekend, the College Bowl Tournament, the Alpha Chi Omega Lip Sync, the European Club Career Fair and two celebrations for Paul and Priscilla Gray.

HIGHLIGHTS

Throughout the year, we devoted significant attention to improving student and community life through renovation and improvements to CAC facilities. The Kresge renovations for the Americans with Disabilities Act and life safety issues were approved, and construction has begun. The portions of the project addressing program needs is awaiting final approval. Improvements to the condition of all CAC facilities continued to be a priority. We added additional lounge seating, improved building lighting, and increased our attention to repair and/or maintenance needs.

The department improved the level of customer service by cross training student receptionists and schedulers to more effectively assist with event-related questions. Through training programs and improved communication efforts, the service staff have gained a better understanding of the mission of CAC and have been able to provide quality service to the MIT community.

The department's student employment program expanded to include staffing of the Coffeehouse with over one hundred students and two graduate interns. This new integrated student employment system standardizes hiring processes, position descriptions, salaries and training across the department. We created and piloted an evaluation process designed to recognize outstanding job performance among the student staff.

During the past year, the CAC assumed direct management responsibility of the Stratton Student Center Gameroom and the Coffeehouse. The addition of these enterprises is a result of the dissolution of the Student Center Committee. It complements existing business areas, such as the Source (information desk and box office) and the CAC Vendor Program. Combined, these areas constitute a nucleus of business activity that provides the MIT community with a variety of goods and services, as well as a funding source for the CAC Program Board and other non-budgeted department expenditures.

In addition to these CAC-managed enterprises, the department also serves as the property manager for fifteen Stratton Student Center retail tenants. Although the portfolio of retail tenants maintained full occupancy throughout the year, we anticipate that some tenant turnover will occur next year because of lease expirations and options terms that will not be exercised.

PROJECTS AND GROUPS

The first year for the CAC Program Board included developing a structure, formulating program areas, encouraging student participation, and increasing active membership from four to twenty students. The Program Board co-sponsored a series of small events featuring MIT student musicians, poetry readings and "open mic" nights in the

Coffeehouse to create opportunities for relaxation and interaction within the MIT community. Special social events, open to all MIT community members, included the electronic music series "Phases" and the annual "Battle of the Bands". The CAC Program Board also worked with the Undergraduate Association Social Council, Residence and Campus Activities and other campus organizations to develop the successful Spring Weekend.

The past year has proven to be one of consistent improvement for the Coffeehouse. The Coffeehouse implemented a new management structure, including a graduate assistant and a food service consultant. These changes have allowed the Coffeehouse to better evaluate their financial status as well as the product and pricing mix in an effort to better serve customers and the entire MIT community. The Coffeehouse will continue to expand the potential to serve the community in a cost effective manner.

With 130 new student members, the Hobby Shop's membership this year reached 310. In addition to popular seminars and individual instruction in project design and construction, it offered a new seminar, "Woodwork Design and Fabrication", which was taught in association with the Edgerton Center. The broad range of Hobby Shop individual projects included medical and research instruments, a CCD camera adapted for a telescope, and a variety of wooden furniture and accessories. As a laboratory for invention and construction, students in Courses 2, 4, 15, 21, as well as UROP and Freshmen Seminars, used the shop facilities for class projects. For the first time, Hobby Shop students exhibited their work in the Wiesner Student Art Gallery.

The Student Art Association reached capacity enrollment this year with 1,082 students. Traditional classes in ceramics, painting, drawing, intaglio printing, photography and videography were offered. Two additional classes in bead making and wood block and lino printing were held during IAP. The second annual Schnitzer Prizes in the Visual Arts were awarded to first place winner Francisco J. Ortiz G, second place winner Benjamin C Matteo '97, and third place winner Xingheng Wang '99. The Wiesner Student Art Gallery exhibited a variety of student art work, including photography, Chinese painting, origami, ceramics, woodwork, sculpture, drawing and painting. Works of the winners of the List Fellowships and Schnitzer Prizes highlighted the exhibition season.

The Office of Special Community Services continued to support wide variety of important community activities. The MIT Activities Committee (MITAC) organized over sixty five events, attended by approximately 4,000 members of the MIT community. The MITAC Executive Board, composed of office staff and the co-conveners of the campus MITAC Committee and the Lincoln Lab Committee, met regularly during the year and established policies and procedures. In addition, a new MITAC staff person from Lincoln Laboratory began sharing the responsibility of running the MITAC Lincoln Laboratory Office.

The MIT Quarter Century Club currently has over 2,700 members, made up of employees, retirees and honorary members who have achieved twenty five years or more of service to the Institute. During the year, the thirteen member board of directors revised and updated the 1990 Quarter Century Club's constitution and bylaws. The events held during the past year include the summer picnic, which had an attendance of over 800 members and guests. The Silver Club High Tea was attended by seventy members, while the annual Holiday Gathering hosted over 300 members. The induction luncheon welcomed 100 of the 121 new members this year.

The 1996 United Way Campaign surpassed the goal of \$300,000 set for this year; there were approximately 1,200 people who contributed a total of \$303,000 while the number of Leadership Givers that donated \$1,000 or more increased from 58 to 69. For the first time, retirees were solicited for United Way contributions. A volunteer United Way Steering Committee was formed to provide vision and guidance to OSGS staff in carrying out the annual campaign. Composed of Institute staff members from across the MIT community, the committee helped to develop programs aimed at increasing participation and increasing the level of gifts. The committee also helped to plan and organize community awareness activities.

Organized in 1994, the Association of MIT Retirees is open to everyone who has retired from the Institute, regardless of length of service. The current membership consists of over 670 retirees. Over a dozen programs took place during the year with speakers discussing various subjects related to health and other areas of interest. An Association of MIT Retirees directory was created in the fall for those that wished to be a part of the organization. Listing information for the directory was supplied from questionnaires sent to all recent New England based retirees.

A database was also set up for all Association members and is updated as various changes occur within the membership.

Approximately 700 retirees were honored at the Retirement Dinner held in September. Before the event, a retirement dinner committee, comprised of representatives of various MIT offices, implemented innovative ideas and suggestions to make the dinner a memorable one. Retirees in the class of 1996 were sent a voluntary "Historical Questionnaire" from the Association of MIT Retirees that requested historical information and their impression of MIT. As a result of the completed questionnaires returned, a video called "Video Retrospective" produced by MIT Video Productions, was shown during the program. A total of 36 retirees as of 1996 talked about their MIT experiences in their own words.

More information about the Campus Activities Complex can be found on the Web at the following URL:
<http://web.mit.edu/campus-activities/www/>.

Phillip J. Walsh

COMMITTEE ON DISCIPLINE/STUDENT CONFLICT RESOLUTION AND DISCIPLINARY PROCEDURES

This year marks the first complete year for the new conflict resolution system. This written, specific set of guidelines provides students and other members of the community with a variety of avenues for resolving complaints and dispensing discipline. The system was implemented in part to help widen the involvement of the office in the disciplinary process so that the system would be understood by all involved as both rational and comprehensive, involving both students and staff, with clearly defined parameters. To a degree we have accomplished this purpose.

Betty Sultan has overseen the evolution of the new system and the establishment of hearing panels within the office. Not all the bugs are out of the system but we are well on our way to an improved, rational system that with the Committee on Discipline (COD) offers the community a process we can live with.

Chaplaincy

The chaplaincy at MIT continued to make good use of Building W11, the Religious Life Center. Interfaith dialogue is alive and well, and plans are under way for expanded conversations during the coming year on the notion of cosmology within the great faith traditions.

In the fall the chaplaincy cosponsored a panel discussion on the religious right and their influence on the upcoming election. Speakers included Dr. William C. Martin from Rice University, Dr. Preston Williams from Harvard Divinity School, Dr. Charles Stewart from MIT, and Dr. Haddon Robinson from Gordon-Cromwell Theological Seminary. The occasion was prompted by the public television series, *With God on Our Side*. Dr. Martin authored the book of the same name that accompanied the series.

During IAP, Dr. Peter Gomes from Harvard Divinity School spoke regarding his best-selling book, *The Good Book*. The chaplaincy is stable with appropriate procedures in place for welcoming new chaplains. Last August, Dr. Constance Parvey became the new Lutheran Chaplain, a role she played in the 1970s when she was the first Lutheran chaplain on the campus. She left here to go to work in Geneva with the World Council of Churches and has now returned to MIT to complete her career. Father Tom Holohan left the Catholic chaplaincy at the end of June and Father Paul Reynolds will begin work in August. Sister Mary Karen Powers underwent open heart surgery during the winter, returned to work in June but will leave her ministry here in August. She will be greatly missed for she was the first woman to serve in the Catholic chaplaincy at MIT and she drew on her extensive Hospice skill to open new avenues of service in our Infirmary.

The Boston-Cambridge United Ministry in Higher Education sponsored the meeting of the Gay-Lesbian Caucus of the United Church of Christ in the summer of 1996 on our campus. Because of the willingness of MIT to host events that some campuses find controversial, we have become a center of intellectual activity equivalent to what occurs in other areas of Institute life. The Technology and Culture Seminars also contributed to this vitality by bringing a wide

range of speakers to campus. Directed by the Episcopal chaplain, The Reverend Jane Gould, this effort has wide influence and support on campus.

Speakers

This past year we had four speakers on campus co-sponsored by the Dean's Office. Dr. William Martin and Dr. Peter Gomes have been mentioned. Dr. Charles Murray was here during IAP, co-sponsored by the Political Science Department from which he had graduated. Dr. Florence Ladd, who headed the Bunting Institute at Radcliffe College until her retirement in June, was also invited back to campus to read from her new novel, *Sarah's Psalm*. Dr. Ladd had previously worked at MIT. This event was co-sponsored by the Women's Studies Program. These efforts mark a revived effort on the part of this office to initiate cooperative ventures with other areas of the Institute. Students are now actively seeking ways to bring to campus and we have offered both support and a model by which it can be done.

Community Matters

The death in October 1996 of Benjamin Hammond, a student in the Graduate Program in Speech and Hearing, a joint Harvard-MIT program, was a profound loss to the community. A graduate of Harvard College, Ben Hammond was an exceptional talent lauded by those who taught him and those who counted him a friend. He died of heart failure resulting from a defect that had been thought to be under control.

IAP ended with a bit of a scare for students who feared they had been exposed to tuberculosis. Over two hundred students were tested for the disease in two residence halls. A much smaller number were given the opportunity to take treatment that would all but insure they would not develop the disease. This incident reminds us of how vulnerable communities such as ours are to diseases once thought fully contained. Sudden death and exposure to serious illness are only two tests of the resilience of our community; we respond well to such tests because we are a diverse and able people bound together by shared educational goals. We may justly be proud of our strength even as we regret those events that ask us to depend upon it.

Robert M. Randolph

ATHLETICS, PHYSICAL EDUCATION AND RECREATION DEPARTMENT

The department is dedicated to providing adaptive, high-quality student-oriented physical education, athletics, recreation and intramural programs that encourage opportunities for participation, competition, confidence and leadership through enhancing the athletics and health fitness environment. The department's association with other units in the Dean's Office is proving to enhance the quality of education experiences for student-life and learning, and community services at MIT.

Continuing interest in the upgrading of all facilities, combined with a generous financial commitment from Maurice ('49) and Lynn Katz, resulted in the initiation of one major project: the West Tennis Courts were completely renovated. MIT provided funding for the installation of a state-of-the-art fabric tennis skin to replace the much-deteriorated existing tennis bubble. In addition, all courts received a plexi-pave resurfacing, completing the deferred maintenance of the entire facility. Significant progress was made toward the development of the central athletics facility that includes a 50-meter swimming pool, health-fitness center, sports medicine facility and additional locker rooms. Professors John Benedick and Gordon Kelly led a department initiative that enjoined Assistant Planning Director Michael Owu for several campus visits to view "state-of-the-art" 50-meter pool facilities. Sports medicine employees, including members of our partnership team from the Medical Department, offered their expertise and perspective on the sports medicine facility. Finally, Professor Halston Taylor worked diligently with the planning group to provide guidance not only for the central athletic facility weight training and fitness facility, but also to guide the renovation of the existing health-fitness area planned for the summer of 1997. Substantive improvements were made in the athletics training area that include an additional ice-making machine and the replacement of a whirlpool turbine. Patients and staff enjoyed the addition of air conditioning in the training room, and improved air exchange on the whole enhanced that area as well as the pistol/rifle range. The strength of town and gown relationships continue to be reinforced as MIT served as host to more than 40 outside events in Athletics Department spaces.

While actual sale of athletics cards remained depressed during this fiscal year, systems were put in place to enhance the ease with which cards could be purchased. Computer tracking of sales and better record keeping identified card-deficient users of our facilities. Our recent reconciliation of physical receipts and deposit records for card sales revealed the procedural control recommended by the Audit Department's on-site visit in 1996.

Registrations for 1996-97 were 8264, which is 334 higher than in 1995-96. Undergraduates taking classes for credit numbered 4890, while 3374 (undergraduates, graduates, staff, spouses, alumni) registered as non-credit students. Sixty-five courses were offered, with the highest registrations coming from aerobics, skating, weight training, aquatics and tennis. IAP had a record enrollment, with 1815 registrations for the 34 offerings. No students were denied graduation solely due to the physical education requirement. Eleven courses on a fee basis are to be offered during the summer of 1997. We employed 15 full-time physical education instructors and 45 part-time instructors. Registration for classes through the department's computerized lottery (PELOTT) system proceeded almost flawlessly. This system has processed nearly 14,000 students since its inception in 1995. For the fourth consecutive year, our physical education full-time instructors trained and led approximately 100 student leaders through another successful MOYA Project, an R/O lead-off activity.

Intramural participation reached new highs as 9,332 students exhibited their loyalties in competing for their dormitory floors or fraternity houses in 16 activities. Club Sports program needs were analyzed and financial support guidelines were established and implemented, resulting in more equitable distribution of funding. Of the 39 programs registered this year, more than 12 competing club sports received financial assistance.

The actual number of outstanding performances by our student-athletes is too great to comprehensively mention in this document. Highlights of the 1996-97 academic year, however, are as follows:

- Pardis Sabeti, Women's Tennis, was named a Rhodes scholar.
- John Walberg, Track and Field, was a NCAA National Division III Champion in the hammer throw and a recipient of an NCAA Post-Graduate scholarship.
- Katherine Merriless was a recipient of the MAIAW Achievement Award for her "demonstrated expertise and success" in the sport of Field Hockey and an NCAA Post-Graduate scholarship.
- Myong-Sin Yi was named to the US National Pistol Development Team.
- The Men's Gymnastics Team was recognized for their academic excellence as they garnered first-place nationally for achieving the highest aggregate GPA across all men's gymnastics programs.
- The Women's Crew Varsity Four represented MIT in the first-ever NCAA National Championships, finishing 6th out of 18 crews competing across Divisions I, II, and III.
- 18 men and women were recognized as CoSida National Scholar-Athletes.

More information about the Athletics, Physical Education and Recreation Department can be found on the Web at the following URL: <http://web.mit.edu/athletics/www/Intercol.html>.

Richard A. Hill, Candace L. Royer

MIT CARD, HOUSING AND FOOD SERVICES

By offering a range of services to the MIT community, we accomplish our mission--to assist MIT in its daily efforts. The MIT Card office provides identification, access and customer transaction services. The Housing and Food Services office aims to provide efficient management of housing facilities, budget, food service and sales revenue.

Because of early retirements this past year, we redesigned our management structure. Our goal through this transition was to produce better services at less cost with fewer staff.

MIT CARD OFFICE

This year, the office provided an MIT Card to 1,937 new employees. Two departments took advantage of our off-site service, where our staff takes photos at the department's headquarters and then delivers the completed cards. We also provided 2,450 temporary ID cards for summer conference participants for to give them access to dormitory, meal-plan, and parking services.

As the number of uses for the card increases, so does the number of users. In addition to students, employees and their spouses, members of the Corporation, contractors working at the Institute, new Lincoln Lab employees, and retirees can all now use the card.

The Card Office has undergone some changes in the past year. The office itself has moved to a more accessible location on the first floor. To accommodate new uses, the office has begun negotiations to purchase new hardware and software products that will allow quicker updates to the security system, more flexibility, and shorter response times.

HOUSING OFFICE

The Housing Office continued to develop its management team concept. The principle remains to produce better service at less cost to MIT.

We continued to develop a new house manager job description that meets evolving residence management goals. In addition to everyday management duties, our house managers serve the residential community in other critical ways, attending dormitory and executive committee meetings, tutor training sessions, house meetings, and even social gatherings; they come work with alumni, conference services staff, and R/O workers. We continued to build this central position description to better reflect the authority and responsibility of the UESA residence life program.

We continued our effort within budget constraints to produce the best possible renovation and maintenance program, addressing customer needs in a swift, professional and cost-effective manner. We acted in order to insure that our students had a positive experience. Estimated cost for the fiscal year is \$3.7 million in renovations and maintenance in the residential system.

Program Highlights

| | |
|-------------------------|-------------------------------------------------------|
| Roof Replacement | W1, 62-64, E55, W61 |
| Window Replacement | NW61, W61 |
| Waterproofing/Painting | E55, W7, W1, W13, 62-64, W4 |
| Bathroom Renovations | E55, 62-64, W13, NW61, W4, W51, W61, W70, W71, W85 |
| Kitchen Renovations | E55, W51, W85 |
| Plumbing and Mechanical | E55, 62-64, W1, W13, W4, W51, W61, W70, W71, W84, W85 |
| Electrical Renovations | E55, 62-64, W1, W4, W51, W85 |
| Paint Program | All dorms |

We began to build a data base that would allow access to off-campus rental listings on the MIT community intranet. We have slated this program start-up at the beginning of the fall term. This office continued to provide a valuable service to MIT students, staff, faculty and visitors. Many service users are from other countries. The demise of rent control in Boston, Cambridge and Brookline, coupled with a strong economy, has made the off-campus rental market one of the worst in the country. The vacancy rate was down, meaning there were fewer apartments advertised than this time last year.

Because of the tight off-campus rental market, there were far more applicants for campus housing than in the past several years. We accommodated the majority of first-year graduate students who applied for campus housing. Those not accommodated wanted specific buildings or apartment types that simply were not available. The addition of new five-year degree program and the increase in the class size at Sloan School of Management are further taxing the limited graduate and family housing resources. This year we accommodated 27 percent of the graduate students on campus, down from 30 percent two years ago.

HFS continued to increase its use of MITSIS. All residence houses and house managers and central department offices like Food Services, the MIT Card Office, and Evening and Nightwatch Dorm Patrol management used MITSIS for billing, checking registrations, addresses, and other tasks. With this system, we can locate any student 24 hours a day and seven days a week in case of emergency. House managers worked with student room assignment chairs to input up-to-date room assignments much faster and with more accuracy than ever before.

FOOD SERVICES

MIT was a 1997 test site for Pan Geos Fresh Flavors of the World. The following dining locations featured components of this new program: Walker, Pan Asia; Networks, Wraps; Lobdell, Juice Bar; Next House, Pasta Kitchen. Two breakfast carts were implemented at Next House and Burton House with improved student satisfaction. Semester customer satisfaction surveys in all dining locations showed improved ratings from prior year. The Dome Cafe, on the fourth floor of Building 7, opened in September and received great customer satisfaction response.

MIT Dining Committee meetings were open to the community and were well attended with excellent response from our customers. Our Campus Dietitian, nutrition interns and Lobdell Student Manager focused on healthy eating by highlighting healthy options, providing nutrition booths for Nutrition Month and working with the student group CHEW (Choose How to Eat Wisely).

Our UESA Dining mission continued to improve overall customer satisfaction in all dining locations as measured by the customer. Proposals developed to accomplish the mission included:

- Expansion of Pan Geos throughout campus;
- Opening McCormick Dining as a pilot site;
- Renovation of Refresher Course (1st floor Sloan School);
- Introduction of late night delivery programs for West Campus from Networks;
- Expansion of seating in Lobdell for lunch and Networks for dinner;
- Opening Lobby 13 as a new dining location; and
- Continuing the customer communication plan;

A one year contract was negotiated with Aramark for the fiscal year ended . We began negotiations with Aramark for an additional one year contract to expire July 1, 1998. This negotiation is ongoing.

Lawrence E. Maguire

RESERVE OFFICERS' TRAINING CORPS PROGRAMS

AIR FORCE ROTC

The Air Force Reserve Officers' Training Corps (AFROTC) program at MIT provides challenging and comprehensive leadership and academic training for students attending MIT, Harvard, Tufts and Wellesley. We continue to recruit and commission men and women as second lieutenants in the United States Air Force. Year-end enrollment in AFROTC as of June 1997 was as follows:

| | Freshmen | Sophomores | Juniors | Seniors | Total |
|-----------|----------|------------|---------|---------|-------|
| MIT | 13 | 12 | 12 | 5 | 42 |
| Harvard | 1 | 4 | 4 | 1 | 10 |
| Tufts | 1 | 0 | 1 | 1 | 3 |
| Wellesley | 6 | 1 | 0 | 0 | 7 |
| Total | 21 | 17 | 17 | 7 | 62 |

The assortment of special cadet activities continued unchanged from previous years and included a freshman orientation program emphasizing Air Force knowledge, physical fitness, and drill; an Air Force Dining-In, a formal dinner with guest speaker; and the Tri-Service Military Ball, parade, awards ceremony, and commissioning ceremony at the USS Constitution.

Highlights of the year include:

- In the fall term, Professor Meyer lectured and Colonel Rutley and Mr Valentino led the recitations for 17.471, American National Security Policy, to 40 students (25 were non-AFROTC).
- In the spring, Detachment 365 sponsored a field day at MIT for Air Force ROTC cadets from six other detachments in the surrounding area.
- AFROTC cadre participated with members of the ROTC Oversight Committee in reviewing the AFROTC course material aimed at designing a "modified ROTC" program. The goal of the "modified ROTC" would be

to have a military cadet track to commissioning and a civilian student track to enhance leadership knowledge and experience.

- Seven MIT cadets received commissions as second lieutenants on June 6, 1997. One MIT cadet was commissioned on January 14, 1997. Colonel Rutley administered the oath of office. One Harvard cadet was commissioned on June 4, 1997.
- The AFROTC program provided MIT cadets with over \$878,548.00 for tuition for the 1996-97 academic year.
- The cadre for the 1996-97 academic year included Colonel Rutley, Major Gerrig, Captain Eherenman, Captain Tagg, SMSgt Trevino, TSgt Briggs, and Mrs Cronin.

Colonel William D. Rutley

ARMY ROTC

The purpose of the Army Reserve Officers' Training Corps (ROTC) is to provide instruction and training in military science subjects, to include a focus on leadership development. When coupled with the completion of a bachelor's degree, this training qualifies selected students for commissions as officers in the Active Army, Army Reserves, or Army National Guard.

This year a total of 67 students participated in our program. At year's end 64 students were enrolled. Of those 64 students 20 (31 percent) were minorities, including 9 women.

| | Freshmen | Sophomores | Juniors | Seniors | Total |
|-----------|----------|------------|---------|---------|-------|
| MIT | 3 | 9 | 5 | 6 | 23 |
| Harvard | 4 | 3 | 3 | 7 | 17 |
| Wellesley | 4 | 1 | 1 | 0 | 6 |
| Tufts | 5 | 8 | 2 | 3 | 18 |
| Total | 16 | 21 | 11 | 16 | 64 |

Of the 23 enrolled MIT students, 15 are on scholarship, while 5 of the 8 non-scholarship students won scholarships this year.

In the 1996-97 academic year, we commissioned highly qualified graduates who promise to represent our program well in both the active US Army and the US Army Reserves. In the spring, scholarship selections were announced with ten Tier 1A (\$22,000 annually) scholarships awarded to prospective freshmen at either MIT or its cross-enrolled schools, worth almost \$900,000 for four years. Additionally, 13 two or three year scholarships were awarded to freshmen or sophomore students already on campus, amounting to almost \$400,000 in awards.

This year the Army ROTC Department commissioned 12 new second lieutenants, three of whom were from MIT. Of the 12, five are entering the reserves, and seven will be reporting to active duty.

Social highlights for this year included a formal military ball where cadre, cadets, and guests dined and danced. Army ROTC sponsored the annual Tri-Service Awards Banquet with 87 cadets and midshipmen receiving awards from 37 organizations. Army ROTC supported the MIT Community Service Fund by participating in the 4-mile road race around the Charles River Basin. Tri-service commissioning ceremonies at Tufts, Harvard, and for MIT, at the USS Constitution were memorable events marking the transition to officer.

On- and Off-campus learning opportunities continued to attract cadets who voluntarily trained at Fort Benning, Georgia (Airborne School); Fort Campbell, Kentucky (Air Assault School); and other US posts (troop leadership). Participation continued strong in the MIT Pershing Rifles Company, a group of both ROTC and non-ROTC students dedicated to the pursuit of excellence in leadership and tactics.

Most faculty positions changed this year. The department changed commanders with Lieutenant Colonel Creel retiring in December and Lieutenant Colonel Rooney arriving in March 97. Captain Cho replaced Captain Lewis, and Master Sergeant Velez joined the battalion, replacing Master Sergeant Holley who retired last year. Also,

Captain Filosa replaced Major Pettigrew as the Recruiting Officer, and Sergeant Thrall replaced Staff Sergeant Newby as the personnel sergeant.

More information about this department can be found on the Web at the following URL:
<http://web.mit.edu/armyrotc/army.html>.

Lieutenant Colonel Robert R. Rooney

NAVY ROTC

The Naval Reserve Officers' Training Corps (NROTC) program at MIT provides challenging and comprehensive leadership and academic training for students attending MIT, Harvard and Tufts. In the 1996-97 academic year, a total of 8 graduates were commissioned. Program enrollment just prior to June commencement was as follows:

| | Freshmen | Sophomores | Juniors | Seniors | Total |
|---------|----------|------------|---------|---------|-------|
| MIT | 9 | 10 | 15 | 3 | 37 |
| Harvard | 10 | 9 | 7 | 4 | 30 |
| Tufts | 3 | 2 | 3 | 0 | 8 |
| Total | 22 | 21 | 25 | 7 | 75 |

The Navy's financial assistance totaled approximately \$1,624,000 for the year, including about \$836,000 for MIT students. Approximately 96 percent of all NROTC students receive full tuition, payment for books, and a monthly stipend. We are expecting total enrollment to rise significantly in the fall with a projected 43 new freshmen entering the program.

Annual activities included freshman orientation held in Newport, Rhode Island, and the Navy and Marine Corps Birthday Ball, where LCDR Andrews, USN, was the honored speaker. The MIT NROTC Color Guard participated in the Boston Veteran's Day parade, as well as in several MIT football games. The midshipman battalion was also active in community service, working closely with the New England Shelter for Homeless Veterans, teaching veterans computer skills. The battalion also helped to restore a local house in working with Habitat for Humanity and performed landscape work for the Boston Park Service.

The MIT NROTC sailing team competed successfully this year. The team sailed to victory at the Georgetown and Cornell regattas and hosted the third annual Beaver Sailing Regatta on the Charles River, where the team was again victorious. The spring semester also included three military excellence competitions at Villanova, Cornell and Holy Cross.

During the summer, all of the scholarship midshipmen participate in active duty training with deployed naval units. This summer, midshipmen are cruising aboard submarines, maritime patrol aircraft, aircraft carriers, amphibious assault ships, and other vessels.

The MIT NROTC unit hosted the director of Undersea Warfare, Rear Admiral Giambastiani, who discussed technology developments in undersea warfare. The admiral also toured the MIT Tow Tank and received a presentation on the robo tuna and robo pike projects. The Command Master Chief of the Navy, Master Chief Hagan, also visited and discussed enlisted sailors' needs in the fleet.

The culmination of four years of training was reached on June 6, 1997, as four MIT students were commissioned as Ensigns in the United States Navy in a service alongside the USS Constitution. The guest speaker was Chief of Naval Education and Training, Vice Admiral Patricia Tracey.

I will be relieved on August 11, 1997, by Captain Randall Preston, USN. These past three years as visiting professor of naval science at MIT have been both personally and professionally rewarding. It has been a joy to prepare some of MIT's finest students for service as officers in the Navy and Marine Corps. I appreciate MIT's support for our program, especially the renovation of building W59, which will be an excellent facility for our staff and midshipmen.

More information about this department can be found on the Web at the following URL:
<http://www.mit.edu:8001/activities/navyrotc/home.html>

Captain Michael L. McHugh

RESIDENCE AND CAMPUS ACTIVITIES

The Residence and Campus Activities section coordinates and supports the myriad activities related to residence life, student activities, independent living groups, crisis management, conflict resolution and mediation, student governments and public service. These functions provide students with opportunities to develop important life skills outside the classroom, including that of leadership, communications, group dynamics, understanding differences, teamwork, and conflict management.

HIGHLIGHTS

Of particular importance this past year have been the numerous re-engineering and transition efforts that RCA staff have contributed to and supported. Staff have served on teams and in other capacities with regard to Co-Curricular Redesign and Implementation, Housing and Residential Life (HARL), Residential System Integration Team (RSIT), Food Services Working Group (FSWG), and the Presidential Task Force on Student Life and Learning. In addition, a number of staff are serving on affinity and/or oversight teams. The Co-Curricular Redesign team worked throughout the year to produce a plan for a new Student Activities Center. The plan was given to a working group to implement during 1997-1998.

RCA staff handled numerous discipline matters with sensitivity and efficiency. Charges included property damage, harassment, and sexual assault, and sanctions ranged from warning to temporary removal from Institute housing and a three-year suspension. In addition, staff served on or chaired hearing panels in the recently revised disciplinary system.

RCA staff members convened the new Lesbian, Bisexual, Gay, Transgender Issues Group which includes LGBT people and allies, fourteen staff members from offices all over the Institute, eight students, and two alumni. Carol Orme-Johnson chairs the group. Task groups have begun working on formulating an official mechanism for responding to anti-gay incidents at MIT, surveying students to assess needs related to sexual orientation and identity, and compiling and distributing a list of resources at MIT for LGBT students. Currently the group is working on activities for LGBT students during R/O. The group also met with the ROTC Implementation Team and with BGALA, the new group of gay and lesbian alumnae.

GenderWorks is a peer training program in gender relations at MIT, founded in 1994 and affiliated with a seminar on sex roles and relationships. This seminar has been taught at MIT for ten years and won the 1997 Sizer award for having made the most significant improvement to MIT education. This year staff and trainers ran fourteen workshops for approximately 400 students and staff. The GenderWorks program has been very successful, with participant evaluations consistently reporting that the workshops helped them better understand the other gender and develop more constructive ways of interacting with them personally and professionally.

Forty-four faculty, staff, graduate students, and undergraduates became certified mediators by completing the Basic Training in Mediation offered by mediation@mit in both January and June this year. [Mediation@mit](mailto:mediation@mit) also produced a video tape of a mock mediation for teaching purposes; the tape used for the first time in the June training. Volunteer mediators have been called on to resolve disputes between individual students and to facilitate a large group exchange of views between opposing organizations.

This past year, undergraduates were again able to indicate their house preferences and receive their assignments using Athena. Over 90 percent of the 726 students who participated received one of their top three choices of residence halls. Temporary assignments also were completed electronically. Crowding for first year students was slightly below recent years, with 120 crowds in the beginning of the semester, compared with 154 the previous year. Over 200 students used the Web-based preference forms for academic year and summer housing requests, as well as cancellations.

The stability resulting from all house masters, and many graduate resident tutors (GRTs), continuing in their positions allowed for particularly well-planned programs and effective response to emergencies in the residences this year. House masters devoted considerable energy and contributed valuable input into the work of the Housing and Residential Life (HARL) team, the Institute Dining Review Committee, and the Task Force on Student Life and Learning. RCA offered training for GRTs and house masters in spite of staff transitions.

Approximately 370 freshmen took residence in one of the Institute's 36 Independent Living Groups following Rush 1996. This was right in line with the ten year average of around 370. In June, MIT completed the renovation of 480 Commonwealth Ave., Boston, a property purchased last spring for use by Sigma Kappa Sorority. This fall, 24 undergraduate members of the sorority will live in the house. This will be MIT's third housed sorority.

The House Fellows Program, now in its ninth year, promotes greater interaction and sense of community between students in the MIT residences and MIT faculty members. This past year, over 20 Fellows were associated with four undergraduate and one graduate house and five Independent Living Groups (ILGs).

Events on campus continued to be strong, with student groups using the major event and party facilities almost every weekend. The metal detector policy continued to be used for major parties, with few problems. A meeting was held to evaluate/communicate with students about using Walker as an event space and the subsequent restrictions at that facility for metal detector events. The event registration process was changed to make it easier for students to register events. RCA and CAC worked together to eliminate steps for students registering events. We are working with the Campus Police, CAC, and individual groups to address continuing problems with event security and planning.

A new alcohol policy form was created this year, and alcohol education is now a part of every registered event that has alcohol.

FINANCIAL OPERATIONS

A policy was developed and implemented by RCA, the Association of Student Activities, the Undergraduate Association, the Treasurer's Office and the Audit Division, to allow recognized student activities to register for an outside bank account in accordance with appropriate MIT procedures. Thus far, over 30 student groups have registered or opened new accounts. This past year, RCA resolved many of students' concerns about the Student Activities Finance Office. Activities have been fully informed about account activity in their accounts during the past few years. New software and check-writing procedures will enable us to perform account transactions in a more timely and efficient manner.

MIT PUBLIC SERVICE CENTER

The Public Service Center (PSC) contributes to the education of students by providing opportunities for them to experience service and by nurturing committed and sustained involvement with the community. The PSC serves as an umbrella organization for campus groups and individuals involved in or interested in community service.

The year-long CityDays program, a unique partnership with the Cambridge Public Schools, was kicked off on Friday, August 30 in collaboration with the School Department of the City of Cambridge. 450 Cambridge grade school children came to MIT where they were hosted by 800 MIT student volunteers who ran a variety of activity stations ranging from lab tours to sports and crafts.

The CityDays Festival is a nice lead in to the LINKS component of the year-long program, as it extends throughout the school year with a mission of improving the quality of science education in the Cambridge Public Schools. Each volunteer spends 1-2 hours/week at one of ten Cambridge elementary schools. The program had about 120 volunteers during the fall semester and 90 in the spring with 20 ILGs and 8 Residence Halls participating.

KEYs is a student-run program sponsored by the PSC which is dedicated to empowering adolescent girls by promoting self-confidence, increasing self-esteem, and unveiling opportunities for potential career paths. The students ran 1 three-day and 7 one-day programs this year which allowed approximately 160 girls and over 30 MIT students to participate in one or more programs during the year.

In addition, the PSC:

- Helped the Panhellenic Association coordinate the Giving Tree program which solicited 1,000 gifts for distribution during the holiday season;
- Sponsored 50 students in the Alternative Spring Break program;
- Hosted the fourth annual MIT/Cambridge Science Expo on April 30, with the assistance of 150 student volunteers;
- Co-sponsored the Community Service Day, in which 170 undergraduates participated, on April 22;
- Awarded PSC Fellowships of \$1,200 to 19 students for public service in elementary schools;
- Awarded \$4,000 fellowships to 6 students for their public service;
- Published *OUTREACH: A Resource Guide for Volunteering in Cambridge and the Greater Boston Area*.

TALBOT HOUSE

Over 500 MIT students visited MIT's Talbot House retreat facility, more than in the previous year. This past year was the creation of an Advisory Board consisting of representative from RCA, UESA, CAC, Alumni Office, GSC, the Safety Office, and Legal Affairs.

Margaret A. Jablonski

NUMBER OF STUDENTS BY COURSE AND YEAR

OFFICE OF THE REGISTRAR

| COURSE NAME | Year | | | | | Total Undergrads | Master/Eng. | Doctoral | | Non-Res. | Spec'l. | Total Grads | Grand Total | Course Number |
|------------------------------------------------------------------|------------|------------|------------|-----------|--------------|------------------|--------------|-----------|-----------|--------------|--------------|--------------|-------------|---------------|
| | 2 | 3 | 4 | 5 | 6 | | | Reg. | Res. | | | | | |
| SCHOOL OF ARCHITECTURE AND PLANNING | | | | | | | | | | | | | | |
| Architecture, IV | 14 | 22 | 19 | 2 | 57 | 162 | 37 | 10 | 6 | 215 | 272 | IV | | |
| Architecture, IV-B | 2 | 1 | - | 1 | 4 | - | - | - | - | - | 4 | IV-B | | |
| Urban Studies and Planning, XI | 1 | 6 | 5 | 1 | 13 | 132 | 47 | 16 | 18 | 213 | 226 | XI | | |
| Program in Media Arts and Sciences, MAS | - | - | - | - | - | 58 | 51 | 2 | 3 | 114 | 114 | MAS | | |
| Total | 17 | 29 | 24 | 4 | 74 | 352 | 135 | 28 | 27 | 542 | 616 | Total | | |
| SCHOOL OF ENGINEERING | | | | | | | | | | | | | | |
| Aeronautics and Astronautics, XVI | 44 | 19 | 28 | 2 | 93 | 140 | 65 | 1 | 2 | 208 | 301 | XVI | | |
| Aeronautics and Astronautics, XVI-B (Cooperative) | - | 1 | - | - | 1 | - | - | - | - | - | 1 | XVI-B | | |
| Aeronautics and Astronautics, XVI-C (Internship) | - | - | 1 | - | 1 | - | - | - | - | - | 1 | XVI-C | | |
| Chemical Engineering, X | 84 | 118 | 94 | 7 | 303 | 64 | 162 | 1 | - | 227 | 530 | X | | |
| Chemical Engineering, X-C | 5 | - | 3 | 1 | 9 | - | - | - | - | - | 9 | X-C | | |
| Civil and Environmental Engineering, I | - | - | - | - | - | 206 | 89 | 5 | 1 | 301 | 301 | I | | |
| Civil and Environmental Engineering, I-C | 6 | 16 | 12 | 1 | 35 | - | - | - | - | - | 35 | I-C | | |
| Civil and Environmental Engineering, I-E | 27 | 22 | 21 | 2 | 72 | - | - | - | - | - | 72 | I-E | | |
| Civil and Environmental Engineering, I-W (Woods Hole) | - | - | - | - | - | 1 | 4 | - | - | 5 | 5 | I-W | | |
| Electrical Engineering and Computer Science, VI | - | - | - | - | - | 159 | 396 | 2 | 13 | 570 | 570 | VI | | |
| Program 1-Electrical Science and Engineering | 80 | 48 | 48 | 20 | 196 | - | - | - | - | - | 196 | VI-1 | | |
| Program 2-Electrical Science and Engineering | 125 | 107 | 73 | 13 | 318 | - | - | - | - | - | 318 | VI-2 | | |
| Program 3-Computer Science and Engineering | 162 | 87 | 79 | 8 | 336 | - | - | - | - | - | 336 | VI-3 | | |
| Electrical Engineering and Computer Science, VI-P (M. Eng.) | - | - | - | - | - | 180 | - | - | - | 180 | 180 | VI-P | | |
| Electrical Eng and Computer Science, VI-PA (M. Eng., Internship) | - | - | - | - | - | 49 | - | - | - | 49 | 49 | VI-PA | | |
| Electrical Engineering and Computer Science, VI-A (Internship) | - | - | - | - | - | 1 | - | - | - | 1 | 1 | VI-A | | |
| Program 1-Electrical Science and Engineering | - | 14 | 25 | - | 39 | - | - | - | - | - | 39 | VI-1A | | |
| Program 2-Electrical Engineering and Computer Science | - | 35 | 22 | - | 57 | - | - | - | - | - | 57 | VI-2A | | |
| Program 3-Computer Science and Engineering | - | 21 | 20 | 1 | 42 | - | - | - | - | - | 42 | VI-3A | | |
| Electrical Engineering and Computer Science, VI-W (Woods Hole) | 35 | 9 | 9 | 1 | 54 | 89 | 81 | 1 | 1 | 172 | 226 | VI-W | | |
| Materials Science and Engineering, III | 1 | - | 1 | - | 2 | - | - | - | - | - | 2 | III-A | | |
| Materials Science and Engineering, III-A | 1 | 30 | 27 | - | 58 | - | - | - | - | - | 58 | III-B | | |
| Materials Science and Engineering, III-B (Internship) | 117 | 100 | 106 | 19 | 342 | 238 | 158 | 4 | 8 | 408 | 750 | II | | |
| Mechanical Engineering, II | 9 | 3 | 7 | 1 | 20 | - | - | - | - | - | 20 | II-A | | |
| Mechanical Engineering, II-A | - | 25 | 12 | - | 37 | - | - | - | - | - | 37 | II-B | | |
| Mechanical Engineering, II-B (Internship) | - | - | - | - | - | - | 1 | - | - | 1 | 1 | II-W | | |
| Mechanical Engineering, II-W (Woods Hole) | 7 | 7 | 4 | - | 18 | 65 | 53 | - | 1 | 119 | 137 | XXII | | |
| Nuclear Engineering, XXII | - | 1 | 1 | - | 2 | - | - | - | - | - | 2 | XXII-A | | |
| Nuclear Engineering, XXII-A (Internship) | 7 | 5 | 2 | - | 14 | 37 | 32 | 1 | - | 70 | 84 | XIII | | |
| Ocean Engineering, XIII | - | - | - | - | - | 5 | 11 | - | - | 16 | 16 | XIII-W | | |
| Ocean Engineering, XIII-W (Woods Hole) | - | - | - | - | - | 25 | - | - | - | 25 | 25 | XIII-A | | |
| Naval Construction and Engineering, XIII-A | - | - | - | - | - | 6 | - | - | - | 6 | 6 | XIII-B | | |
| Ocean Systems Management, XIII-B | - | - | - | - | - | - | - | - | - | - | - | CAES | | |
| Center for Advanced Educational Services, CAES | - | - | - | - | - | - | - | - | - | 56 | 56 | CAES | | |
| Total | 710 | 668 | 595 | 76 | 2,049 | 1,265 | 1,057 | 15 | 82 | 2,419 | 4,468 | Total | | |
| SCHOOL OF HUMANITIES AND SOCIAL SCIENCE | | | | | | | | | | | | | | |
| Economics, XIV | 25 | 36 | 33 | 1 | 95 | 3 | 117 | 12 | 3 | 135 | 230 | XIV | | |

| | | | | | | | | | | | | |
|-----------------------------------------------------------|----------|-----------|------------|----------|----------|------------|-----------|-----------|------------|-----------|-----------|-----------|
| SCHOOL OF HUMANITIES AND SOCIAL SCIENCE | | | | | | | | | | | | |
| Anthropology/Archaeology | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Economics | 1 | 3 | 45 | - | 3 | 1 | - | - | - | 4 | 5 | 28 |
| History | - | - | 1 | - | - | - | - | - | - | - | - | - |
| Humanities | 1 | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Humanities and Engineering | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| Humanities and Science | - | - | 4 | - | - | - | - | - | - | - | - | 4 |
| Linguistics | - | - | - | - | 1 | - | - | - | 2 | 2 | 1 | 1 |
| Literature | - | - | 4 | - | - | - | - | - | - | - | - | 4 |
| Music | - | - | 3 | - | - | - | - | - | - | - | - | 3 |
| Philosophy | - | 1 | 3 | - | 1 | 1 | - | - | - | 1 | 1 | 1 |
| Political Science | - | - | 10 | - | 1 | 3 | - | - | 1 | 3 | 4 | 1 |
| Science, Technology and Society | - | - | 1 | - | - | 1 | - | - | - | 1 | 1 | 1 |
| Writing | - | 1 | 2 | - | - | - | - | - | - | - | - | 1 |
| Total | 2 | 7 | 77 | - | 6 | 6 | - | - | 7 | 12 | 35 | 9 |
| SLOAN SCHOOL OF MANAGEMENT | | | | | | | | | | | | |
| Management | - | - | - | - | - | 74 | - | 19 | 312 | - | - | - |
| Management Science | 1 | 5 | 56 | - | - | - | - | - | - | 2 | 4 | 7 |
| Management of Technology | - | - | - | - | - | 51 | - | - | - | - | - | - |
| Operations Research | - | - | - | - | - | 6 | - | - | - | 2 | - | 2 |
| Total | 1 | 5 | 56 | - | 1 | 131 | - | 19 | 312 | 4 | 4 | 9 |
| SCHOOL OF SCIENCE | | | | | | | | | | | | |
| Biology | - | 8 | 128 | - | 1 | - | - | - | - | 4 | 10 | 11 |
| Undesignated | - | 2 | 17 | - | - | - | - | - | - | - | - | - |
| Brain and Cognitive Sciences | - | - | - | - | - | - | - | - | - | 6 | 3 | 6 |
| Chemistry | - | 4 | 44 | - | 1 | 3 | - | - | - | 14 | 6 | 19 |
| Cognitive Science | - | 2 | 23 | - | - | - | - | - | - | - | - | - |
| Earth and Planetary Sciences | - | - | - | - | 1 | 6 | - | - | - | - | - | - |
| Earth, Atmospheric, and Planetary Sciences | - | - | 10 | - | - | - | - | - | - | 6 | 3 | 4 |
| Mathematics | 3 | 6 | 49 | - | 1 | 1 | - | - | - | 3 | 1 | 17 |
| Mathematics with Computer Science | - | 3 | 8 | - | - | - | - | - | - | - | - | - |
| Meteorology | - | - | - | - | 1 | - | - | - | - | - | - | - |
| Physics | 4 | 3 | 51 | - | 1 | 2 | - | - | - | 6 | 16 | 23 |
| Total | 4 | 28 | 330 | - | 3 | 6 | 12 | - | - | 39 | 39 | 80 |
| WHITAKER COLLEGE of Health Sciences and Technology | | | | | | | | | | | | |
| Health Policy and Management | - | - | - | - | 1 | - | - | - | - | - | - | - |
| Medical Engineering | - | - | - | - | - | - | - | - | - | 3 | 2 | 5 |
| Medical Physics | - | - | - | - | - | - | - | - | - | - | 2 | - |
| Toxicology | - | - | - | - | - | 2 | - | - | - | 2 | - | 2 |
| Total | - | - | - | - | 1 | 2 | - | - | - | 5 | 2 | 9 |

| | | 7 | 10 | 13 | | | | | | | 7 | 10 | 13 | | | | | | | | |
|-----------------------------------------------------------|-----------|------------|--------------|------------|------------|------------|-----------|-----------|------------|----------|----------|-----------|------------|------------|------------|----------|-----------|----------|------------|------------|--------------|
| Without Course Specification | | - | - | - | - | - | - | - | - | - | - | - | - | | | | | | | | |
| Awarded Jointly with Woods Hole Oceanographic Institution | | | | | | | | | | | | | | | | | | | | | |
| Biology | | - | - | - | - | - | - | - | - | - | - | - | - | | | | | | | | |
| Civil and Environmental Engineering | | 1 | - | 1 | - | - | - | - | - | - | - | - | - | | | | | | | | |
| Earth, Atmospheric, and Planetary Sciences | | 2 | 1 | 2 | - | - | - | - | - | - | - | - | - | | | | | | | | |
| Electrical Engineering and Computer Science | | - | - | - | - | - | - | - | - | - | - | - | - | | | | | | | | |
| Ocean Engineering | | 4 | - | 2 | - | - | - | - | - | - | - | - | - | | | | | | | | |
| Grand Total | 25 | 109 | 1,031 | 141 | 164 | 465 | 28 | 82 | 534 | 1 | 4 | 11 | 107 | 141 | 240 | 6 | 14 | 6 | 308 | 514 | 2,287 |

NUMBER OF WOMEN STUDENTS BY COURSE AND YEAR

OFFICE OF THE REGISTRAR

| COURSE NAME | Year | | | | | Total Under grads | Master/ Eng. | Doctoral Reg. | Non-Res. | Spec'l. | Total Grads | Grand Total | Course Number |
|------------------------------------------------------------------|------------|------------|------------|-----------|------------|-------------------|--------------|---------------|-----------|------------|--------------|--------------|---------------|
| | 2 | 3 | 4 | 5 | 6 | | | | | | | | |
| SCHOOL OF ARCHITECTURE AND PLANNING | | | | | | | | | | | | | |
| Architecture, IV | 8 | 13 | 12 | 1 | 34 | 53 | 15 | 6 | 4 | 78 | 112 | IV | |
| Architecture, IV-B | 1 | - | - | - | 1 | - | - | - | - | - | 1 | IV-B | |
| Urban Studies and Planning, XI | - | 3 | 4 | - | 7 | 52 | 22 | 11 | 7 | 92 | 99 | XI | |
| Program in Media Arts and Sciences, MAS | - | - | - | - | - | 13 | 10 | - | 1 | 24 | 24 | MAS | |
| Total | 9 | 16 | 16 | 1 | 42 | 118 | 47 | 17 | 12 | 194 | 236 | Total | |
| SCHOOL OF ENGINEERING | | | | | | | | | | | | | |
| Aeronautics and Astronautics, XVI | 15 | 4 | 7 | - | 26 | 22 | 5 | - | 1 | 28 | 54 | XVI | |
| Aeronautics and Astronautics, XVI-B (Cooperative) | - | 1 | - | - | 1 | - | - | - | - | - | 1 | XVI-B | |
| Chemical Engineering, X | 48 | 63 | 46 | 5 | 162 | 19 | 37 | 1 | - | 57 | 219 | X | |
| Chemical Engineering, X-C | 2 | - | 1 | 1 | 4 | - | - | - | - | - | 4 | X-C | |
| Civil and Environmental Engineering, I | - | - | - | - | - | 50 | 20 | 4 | - | 74 | 74 | I | |
| Civil and Environmental Engineering, I-C | 4 | 10 | 5 | - | 19 | - | - | - | - | 19 | 19 | I-C | |
| Civil and Environmental Engineering, I-E | 23 | 16 | 13 | 1 | 53 | - | - | - | - | 53 | 53 | I-E | |
| Civil and Environmental Engineering, I-W (Woods Hole) | - | - | - | - | - | 1 | - | - | - | 1 | 1 | I-W | |
| Electrical Engineering and Computer Science, VI | - | - | - | - | - | 24 | 69 | - | 1 | 94 | 94 | VI | |
| Program 1-Electrical Science and Engineering | 20 | 16 | 8 | 4 | 48 | - | - | - | - | 48 | 48 | VI-1 | |
| Program 2-Electrical Engineering and Computer Science | 26 | 26 | 15 | 2 | 69 | - | - | - | - | 69 | 69 | VI-2 | |
| Program 3-Computer Science and Engineering | 37 | 20 | 12 | 2 | 71 | - | - | - | - | 71 | 71 | VI-3 | |
| Electrical Engineering and Computer Science, VI-P (M. Eng.) | - | - | - | - | - | 26 | - | - | - | 26 | 26 | VI-P | |
| Electrical Eng and Computer Science, VI-PA (M. Eng., Internship) | - | - | - | - | - | 8 | - | - | - | 8 | 8 | VI-PA | |
| Program 1-Electrical Science and Engineering | - | 3 | 743 | - | 10 | - | - | - | - | - | 10 | VI-1A | |
| Program 2-Electrical Engineering and Computer Science | - | 9 | 9 | - | 13 | - | - | - | - | - | 13 | VI-2A | |
| Program 3-Computer Science and Engineering | - | 2 | 2 | - | 5 | - | - | - | - | - | 5 | VI-3A | |
| Electrical Engineering and Computer Science, VI-W (Woods Hole) | - | - | - | - | - | - | 1 | - | - | 1 | 1 | VI-W | |
| Materials Science and Engineering, III | 23 | 4 | 2 | - | 29 | 17 | 19 | - | - | 36 | 65 | III | |
| Materials Science and Engineering, III-B (Internship) | 1 | 21 | 15 | - | 37 | - | - | - | - | 37 | 37 | III-B | |
| Mechanical Engineering, II | 34 | 26 | 29 | 1 | 90 | 37 | 10 | - | 1 | 48 | 138 | II | |
| Mechanical Engineering, II-A | 3 | 2 | 2 | - | 7 | - | - | - | - | - | 7 | II-A | |
| Mechanical Engineering, II-B (Internship) | - | 7 | 4 | - | 11 | - | - | - | - | - | 11 | II-B | |
| Nuclear Engineering, XXII | 4 | 2 | 3 | - | 9 | 9 | 7 | - | - | 16 | 25 | XXII | |
| Nuclear Engineering, XXII-A (Internship) | - | 1 | - | - | 1 | - | - | - | - | - | 1 | XXII-A | |
| Ocean Engineering, XIII | 4 | 2 | - | - | 6 | 10 | 2 | - | - | 12 | 18 | XIII | |
| Ocean Engineering, XIII-W (Woods Hole) | - | - | - | - | - | 1 | 1 | - | - | 2 | 2 | XIII-W | |
| Naval Construction and Engineering, XIII-A | - | - | - | - | - | 1 | - | - | - | 1 | 1 | XIII-A | |
| Center for Advanced Educational Services, CAES | - | - | - | - | - | - | - | - | 1 | 1 | 1 | CAES | |
| Total | 244 | 235 | 176 | 16 | 671 | 225 | 171 | 5 | 4 | 405 | 1,076 | Total | |
| SCHOOL OF HUMANITIES AND SOCIAL SCIENCE | | | | | | | | | | | | | |
| Economics, XIV | 15 | 13 | 9 | 1 | 38 | 1 | 30 | 4 | 1 | 36 | 74 | XIV | |
| Anthropology/Archaeology, XXI-A | - | 1 | - | - | 1 | - | - | - | - | - | 1 | XXI-A | |
| Foreign Languages and Literatures, XXI-F | - | 1 | - | - | 1 | - | - | - | - | - | 1 | XXI-F | |
| Literature, XXI-L | 1 | 2 | 2 | - | 5 | - | - | - | - | - | 5 | XXI-L | |
| Music and Theater Arts, XXI-M | 2 | - | - | - | 2 | - | - | - | - | - | 2 | XXI-M | |
| Writing and Humanistic Studies, XXI-W | - | 3 | - | 3 | 6 | - | - | - | - | - | 6 | XXI-W | |

| | | | | | | | | | | | |
|----------------------------------------------------------------|-----|-----|-----|-----|-----|-------|-----|-----|-----|-----|-------------------|
| Linguistics and Philosophy, XXIV | - | - | 1 | 1 | 1 | 21 | 3 | - | 25 | 26 | XXIV |
| Political Science, XVII | 4 | 3 | 1 | 8 | 6 | 30 | 6 | - | 42 | 50 | XVII |
| Program in Science, Technology, and Society, STS | - | - | 1 | 2 | - | 8 | 2 | - | 10 | 12 | STS |
| Total | 22 | 23 | 14 | 5 | 64 | 8 | 89 | 15 | 113 | 177 | Total |
| SLOAN SCHOOL OF MANAGEMENT | | | | | | | | | | | |
| Management, XV | 22 | 22 | 25 | 4 | 73 | 193 | 22 | 1 | 2 | 218 | XV |
| Management Fellows, XV-A | - | - | - | - | - | 5 | - | - | 1 | 6 | XV-A |
| Operations Research, OR | - | - | - | - | - | 3 | 10 | - | - | 13 | OR |
| Total | 22 | 22 | 25 | 4 | 73 | 201 | 32 | 1 | 3 | 237 | Total |
| SCHOOL OF SCIENCE | | | | | | | | | | | |
| Biology, VII | 99 | 57 | 78 | 3 | 237 | - | 73 | 3 | - | 76 | VII |
| Biology, VII-A | 1 | 2 | 3 | - | 6 | - | - | - | - | - | VII-A |
| Biology, VII-W (Woods Hole) | - | - | - | - | - | - | 19 | - | - | 19 | VII-W |
| Brain and Cognitive Sciences, IX | 9 | 7 | 11 | 2 | 29 | - | 21 | - | 1 | 22 | IX |
| Chemistry, V | 21 | 23 | 19 | 1 | 64 | 1 | 71 | - | - | 72 | V |
| Earth, Atmospheric, and Planetary Sciences, XII | 4 | 10 | 8 | 1 | 23 | 3 | 29 | - | - | 32 | XII |
| Earth, Atmospheric, and Planetary Sciences, XII-W (Woods Hole) | - | - | - | - | - | 2 | 28 | - | - | 30 | XII-W |
| Mathematics, XVIII | 13 | 9 | 8 | 4 | 34 | - | 19 | - | 1 | 20 | XVIII |
| Mathematics with Computer Science, XVIII-C | 3 | 8 | 1 | 1 | 13 | - | - | - | - | - | XVIII-C |
| Physics, VIII | 9 | 10 | 8 | - | 27 | - | 24 | - | - | 24 | VIII |
| Physics, VIII-A | 1 | - | - | - | 1 | - | - | - | - | - | VIII-A |
| Total | 160 | 126 | 136 | 12 | 434 | 6 | 284 | 3 | 2 | 295 | Total |
| WHITAKER COLLEGE of Health Sciences and Technology | | | | | | | | | | | |
| Division of Toxicology, TOX | - | - | - | - | - | 8 | 9 | - | 1 | 18 | TOX |
| Harvard-MIT Division of Health Sciences and Technology, HST | - | - | - | - | - | - | 74 | - | - | 74 | HST |
| Total | - | - | - | - | - | 8 | 83 | - | 1 | 92 | Total |
| Undesignated Sophomores | 10 | - | - | - | 10 | - | - | - | - | 0 | UND |
| First Year | - | - | - | - | 451 | - | - | - | - | 0 | First Year |
| Special -- No Course | - | 4 | - | - | 4 | - | - | - | - | 0 | Special-NC |
| Grand Total | 451 | 467 | 426 | 367 | 38 | 1,749 | 566 | 706 | 41 | 23 | 3,085 Grand Total |

VICE PRESIDENT FOR RESEARCH AND DEAN FOR GRADUATE EDUCATION

GRADUATE EDUCATION OFFICE

The past year represented the first full academic year within the revised organizational structure described in the last annual report. Despite substantial changes in roles and responsibilities, the transition proved to be remarkably smooth. Staffing remained stable in both the Graduate Education Office and the International Students Office.

COMMITTEE ON GRADUATE SCHOOL POLICY

The CGSP continued to operate under its usual structure, even though consideration of alternative arrangements ensued. By the end of the academic year, no decisions had been reached about how the CGSP might be restructured. Indeed, there remains considerable sentiment among members that no change is necessary. We anticipate that this discussion will be revisited in AY98.

An item of continuing interest to the CGSP is the ongoing academic experiment in distance learning, the Systems Design and Management Program (SDM), which was approved in the prior academic year. As agreed, program managers returned to CGSP for an update on its issues and challenges and for discussion about new activities. CGSP continued its approval for SDM's innovations and will seek additional periodic updates.

Consistent with its interest in distance learning, the CGSP also scheduled an extensive discussion with professor Richard Larson about ongoing activities at the Center for Advanced Educational Services (CAES). Academic implications, issues and opportunities were the topic of lively and engaged discussion, and it is clear that the Center is undertaking some aggressive and innovative steps to help define MIT's activities in the distance learning arena.

Among the new programs approved by the CGSP during the past year were a Masters of Engineering in Scientific and Engineering Computation, brought forward by the departments of aeronautics/astronautics and mechanical engineering; and Master's of Science Program in Logistics, sponsored by the Center for Transportation Studies.

In an unusual but most appropriate action, the CGSP approved the posthumous awarding of the M.S. in Health Sciences and Technology to Mr. Benjamin Hammond, an exemplary and gifted third-year student in the speech and hearing sciences program at Eaton-Peabody Laboratory whose sudden death foreshortened his graduate career. By the time of his passing, Mr. Hammond had completed all requirements for the S.M.

RECRUITMENT AND OUTREACH

Under the leadership of deans Langdale and Tyler, recruitment and outreach activities were somewhat refocused. In the past, our principal effort has been towards helping departments to identify and contact prospective applicants to convince them to consider MIT's graduate programs. While that effort will continue to be paramount, we saw possibilities to further improve how we track these potential candidates through a highly decentralized admissions process.

Because our financial resources for recruitment were modestly increased, we have been able to further expand recruitment efforts. The addition of several telephone lines made possible a fully year-round outreach project, staffed by graduate student volunteers, that proved its effectiveness in the past year. Dean Langdale introduced a number of measures and techniques that have improved how we integrate student tracking with our daily recruitment operations, so that we can better determine how well we remain on track towards our self-defined enrollment goals. After a year of effort, we are convinced that we should investigate some of the database enrollment management programs available commercially and adapt one to our operation.

MIT Summer Research Program

The MSRP completed its twelfth summer with the largest group of interns ever. Thirty-two students from across the nation participated, and they produced some of the strongest research presentations that we have seen. By the end of the Summer Term 1997, the program will have graduated four doctorates at MIT alone. We are in the process of updating a 1991 survey of all interns, but preliminary data indicate that many other former interns are nearing completion of the doctorate at other institutions.

Continued funding for the program remains a priority, with two issues that guide our consideration. One issue is the prospect that minority centered programs of all sorts will come under greater, hostile scrutiny nationally in the wake of California's Proposition 209. It is unclear how our current foundation funders might react under such circumstances. Another issue is the growth in interest among MIT faculty for participation, which is heartening. There are many signs that the MSRP has become a part of the institutional fabric, in that more faculty proactively seek a summer intern, offer their own financial resources to support a student, and invite students back independently to their laboratories during the academic year. Furthermore, the schools of architecture and planning and of management have expressed interest in accepting interns. While these developments are exciting, our current funding is largely specific to students majoring in science areas. New, less restricted, sources of support will need to be found.

INTERNATIONAL STUDENTS OFFICE

The past year was marked by significant modernization of the ISO's computing and office equipment infrastructure, the first major upgrade of these facilities in several years. In part these upgrades culminated the transition from the undergraduate dean's operations, and in part they were a conscious effort to reposition ISO technology base towards the future. Future improvements will include network installations, a faster file server and acquisition of new software for production of immigration forms.

These changes have been none too soon, given activities on the national immigration regulation scene. The ISO has watched with great concern as the work of the national commission on immigration reform has moved towards legislation. As we feared, the resulting legislative proposal promises to impose significant, new and greatly expanded requirements on MIT to track its international students. We have taken every opportunity, with our colleagues across the nation, to clarify our serious concerns about the added reporting burden and about the proposed requirement that each school collect and forward a mandatory processing fee. Assuming that the proposals will pass Congress intact, it is our hope to have a voice in shaping implementing regulations that might minimize the impact on this office's operations. However, given the current national climate regarding immigration, it is uncertain that this impact will be reduced, and the ISO may be looking towards further staffing change to accommodate the new federal requirements.

On a more upbeat note, the year was also marked by formal approval for a staff-level position for Kate Baty, who has headed the Host to International Students program for many years. This action has effectively begun to recognize the value of the Host Program to MIT and its many international students, as well as the ongoing effort of Ms. Baty to serve these students and their families. A challenge for the future will be to secure sufficient operational funding for the program, and we are optimistic that this need will be addressed.

Isaac M. Colbert

WOMEN, FOREIGN NATIONAL AND MINORITY GRADUATE ENROLLMENT, AY 1973 TO AY 1997

| Academic Year | Number of Women | Percent Women | Number of Foreign Nat. | Percent Foreign Nat. | Number of Minorities | Percent Minorities | Total Enrollment |
|---------------|-----------------|---------------|------------------------|----------------------|----------------------|--------------------|------------------|
| 1973 | 304 | 9.1% | 927 | 27.9% | 108 | 3.2% | 3,328 |
| 1974 | 318 | 9.5% | 954 | 28.4% | 121 | 3.6% | 3,358 |
| 1975 | 405 | 11.7% | 970 | 28.0% | 151 | 4.4% | 3,468 |
| 1976 | 487 | 13.5% | 1,037 | 28.8% | 155 | 4.3% | 3,603 |
| 1977 | 546 | 14.5% | 1,059 | 28.1% | 178 | 4.7% | 3,774 |
| 1978 | 559 | 14.6% | 1,151 | 30.1% | 157 | 4.1% | 3,824 |
| 1979 | 606 | 15.4% | 1,145 | 29.0% | 147 | 3.7% | 3,944 |
| 1980 | 684 | 16.5% | 1,219 | 29.4% | 150 | 3.6% | 4,146 |
| 1981 | 779 | 17.8% | 1,283 | 29.3% | 174 | 4.0% | 4,384 |
| 1982 | 828 | 18.2% | 1,347 | 29.7% | 140 | 3.1% | 4,541 |
| 1983 | 856 | 19.1% | 1,418 | 31.6% | 145 | 3.2% | 4,489 |
| 1984 | 914 | 19.7% | 1,439 | 31.1% | 143 | 3.1% | 4,631 |
| 1985 | 981 | 20.6% | 1,449 | 30.5% | 141 | 3.0% | 4,757 |
| 1986 | 981 | 19.9% | 1,658 | 33.7% | 139 | 2.8% | 4,920 |
| 1987 | 987 | 19.8% | 1,497 | 30.1% | 144 | 2.9% | 4,979 |
| 1988 | 929 | 19.2% | 1,441 | 29.8% | 154 | 3.2% | 4,832 |
| 1989 | 963 | 20.0% | 1,498 | 31.1% | 159 | 3.3% | 4,822 |
| 1990 | 1,064 | 21.7% | 1,628 | 33.2% | 168 | 3.4% | 4,909 |
| 1991 | 1,092 | 22.0% | 1,674 | 33.7% | 155 | 3.1% | 4,967 |
| 1992 | 1,155 | 23.0% | 1,711 | 34.1% | 190 | 3.8% | 5,019 |
| 1993 | 1,177 | 23.4% | 1,755 | 34.9% | 215 | 4.3% | 5,024 |
| 1994 | 1,154 | 22.7% | 1,744 | 34.3% | 193 | 3.8% | 5,090 |
| 1995 | 1,308 | 24.0% | 1,798 | 33.0% | 229 | 4.0% | 5,465 |
| 1996 | 1,222 | 22.1% | 1,745 | 31.6% | 243 | 4.4% | 5,518 |
| 1997 | 1,354 | 24.6% | 1,842 | 33.5% | 268 | 4.9% | 5,499 |
| TOTALS | 20,299 | 18.8% | 33,547 | 31.1% | 3,899 | 3.6% | 107,792 |

GRADUATE ENROLLMENT FALL 1997

| | Internationals | Women | *Minority | **Non-Resident | Total MIT Enrollment |
|-------------------------------------------------|----------------|-------------|------------|----------------|----------------------|
| School of Architecture & Planning | | | | | 515 |
| Architecture | 184 | 210 | 34 | 28 | 209 |
| Media Arts & Sciences | 79 | 87 | 11 | 10 | 111 |
| Urban Studies Planning | 35 | 27 | 3 | 2 | 195 |
| | 70 | 96 | 20 | 16 | |
| School of Engineering | 824 | 427 | 104 | 15 | 2337 |
| Aeronautics & Astronautics | 80 | 32 | 10 | 1 | 206 |
| Chemical Engineering | 63 | 49 | 12 | 1 | 227 |
| Civil & Environmental Engineering | 144 | 82 | 20 | 5 | 305 |
| Electrical Engineering & Computer Science | 192 | 136 | 27 | 2 | 792 |
| Materials Science & Engineering | 61 | 40 | 3 | 1 | 171 |
| Mechanical Engineering | 149 | 56 | 27 | 4 | 401 |
| Nuclear Engineering | 50 | 18 | 5 | 0 | 118 |
| Ocean Engineering | 41 | 10 | 0 | 1 | 117 |
| Center for Advanced Educational Services | 41 | 3 | 0 | 0 | 0 |
| Systems Design and Management | 3 | 1 | 0 | 0 | |
| School of Humanities and Social Science | 126 | 112 | 14 | 50 | 345 |
| Economics | 61 | 35 | 1 | 12 | 132 |
| Linguistics & Philosophy | 39 | 25 | 1 | 8 | 68 |
| Political Science | 20 | 42 | 9 | 26 | 119 |
| Science, Technology & Society | 6 | 10 | 3 | 4 | 26 |
| School of Management (w/Operations Rsch) | 374 | 234 | 52 | 5 | 895 |
| School of Science | 292 | 293 | 55 | 17 | 992 |
| Biology | 17 | 95 | 10 | 6 | 222 |
| Brain & Cognitive Science | 19 | 21 | 2 | 0 | 50 |
| Chemistry | 47 | 72 | 18 | 6 | 207 |
| Earth, Atmospheric & Planetary Sciences | 57 | 62 | 5 | 1 | 169 |
| Mathematics | 53 | 19 | 1 | 2 | 93 |
| Physics | 99 | 24 | 19 | 2 | 251 |
| Whitaker College | 40 | 91 | 9 | 0 | 293 |
| Toxicology | 7 | 17 | 6 | 0 | 30 |
| Health Sciences & Technology | 33 | 74 | 7 | 0 | 263 |
| Total Graduate Enrollment | 1840 | 1367 | 268 | 115 | 5377 |
| Category as % of Total | 34% | 25% | 5% | 2% | |

* "Minority" refers to underrepresented groups: African Americans, Mexican Americans, Native Americans and Puerto Ricans.
 ** "Non-resident" refers to students who are in non-resident doctoral dissertation status.

WHITAKER COLLEGE

The Whitaker College of Health Sciences and Technology (Whitaker College) is a major interdisciplinary academic and research entity at MIT. Several areas of research and teaching that are pertinent to health, both fundamental and applied, have been developed and been incorporated into Whitaker College.

Current activities in the Whitaker College include the Harvard/MIT Division of Health Sciences and Technology, the Clinical Research Center, the Division of Toxicology, the Center for Environmental Health Sciences, Biomedical Imaging and Computation, and the Center for Biomedical Engineering.

We report here on the events and new initiatives of programs that operate within the College core. The activities of the above departments and centers are reported separately.

BIOLOGICAL IMAGING AND COMPUTATION

Research in imaging and computer simulation takes place in the Whitaker College Biomedical Imaging and Computation Laboratory (WCBICL). In addition to providing a site for the faculty and research staff associated with this effort, the goal of the laboratory is to encourage faculty, research staff and students in relevant departments to collaborate on basic research in imaging technologies and display methods and in simulating and understanding the interaction of radiation of different types with various materials both organic and inorganic.

The resources of the laboratory include seven SUN Microsystems workstations, two Silicon Graphics workstations, two PCs, and two Macintosh computers. Most are directly connected to the MIT Campus Network. A variety of peripheral devices are also available.

One of the most exciting new research areas dealing with the design of radiation therapy has been the development of a new method of treating rheumatoid arthritis using neutrons and boron-loaded pharmaceuticals. This new method has been called "Boron Neutron Capture Synovectomy" by Professor Yanch. Her collaborators in this area include Dr. Alan Davison from the Department of Chemistry and researchers at the Harvard Medical School. Appropriate neutron beams, suitable for patient treatment, are currently being designed using the computation resources of WCBICL.

A second research thrust in the WCBICL is in the area of image analysis and image diagnosis. Areas of major interest over the past two years include the automated analysis of mammograms, algorithms for detection of shape irregularities in images of synaptic vesicles, and the development of new methods of real-time three-dimensional image display. One project dealing with the development of a sophisticated simulation program to model the behavior of gamma photons in Nuclear Medicine imaging is able to link the two major research areas (imaging and radiation transport simulation) in the lab. This system is being used in the design of Nuclear Medicine imaging protocols which will allow early detection of arteriosclerosis. A parallel effort in this area has culminated in the design of a full, 3D human-like computer phantom which is used in the assessment of patient dose in various imaging modalities.

A multi-layer page on the World Wide Web (WWW) in which all the research projects and personnel of the lab are listed has been installed and is currently being modified. The contents of the WWW page will change as research projects proceed and new projects are taken on by individuals in the lab.

The lab currently has 52 registered users consisting of faculty, research staff, graduate students, undergraduate students and visitors from outside MIT who use the resources of the lab remotely. Roughly 30 users are from the Nuclear Engineering Department (NED), 18 are from the Harvard-MIT Division of Health Sciences and Technology (HST) or other parts of the Whitaker College and 14 are from the rest of the MIT community or are remote "visitors."

The WCBICL continues to play an increasing important role in education, particularly with respect to the Department of Nuclear Engineering and Harvard-MIT Division of Health Sciences and Technology doctoral programs. Many of the students in these programs conduct thesis research in the lab; the lab is also used for teaching and experimentation in both HST and NED. The HST laboratory projects are designed to provide practical

experiences in processing physiological data with examples from neurophysiology, cardiology, and two-dimensional imaging analysis. The NED students undertake projects in which they learn the physics of radiation behavior while becoming familiar with one of the four public-domain radiation transport codes available in the lab. Students typically choose to apply their simulation work to research in radiation therapy.

WCBICL also supports a number of undergraduates in their thesis or UROP research.

Jacquelyn C. Yanch

CENTER FOR BIOMEDICAL ENGINEERING

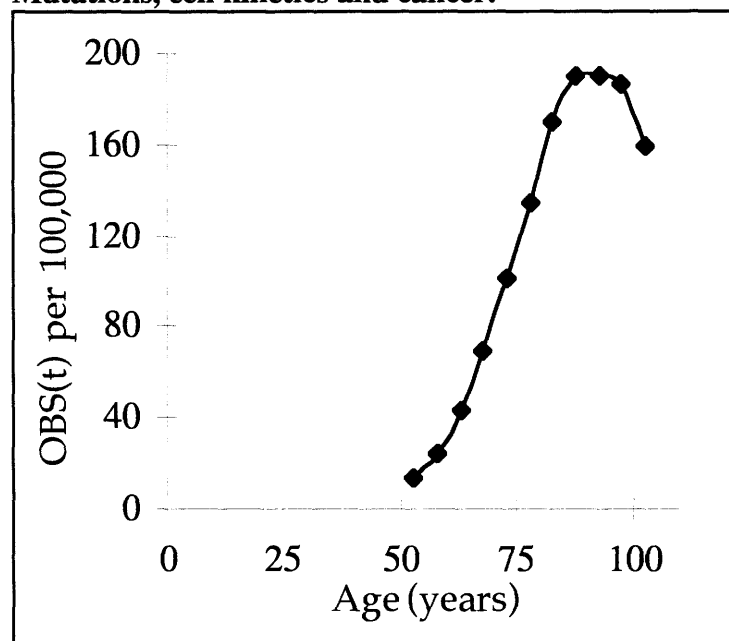
The mission of the Center for Biomedical Engineering (CBE) is to bring engineering into intimate contact with molecular and cell biology, for the purpose of developing innovative approaches to biomedical technology. It brings together efforts of more than 20 investigators at MIT and Boston-area medical institutions in three major thrust areas: Molecular Engineering, Cell & Tissue Engineering, and Physiological Systems Engineering. The first thrust area primarily deals with characterization of physical and chemical properties of individual biomolecules, mainly proteins and DNA, via high throughput assays. The second aims at creating methodologies for delivering biotechnology-based molecular-, cell-, and tissue-based therapies. The third emphasizes minimally-invasive techniques for quantitative assessment of how these biotechnology-based interventions affect physiological function. CBE supports Core Facilities in Biomolecular Interactions & Cellular Responses, Histology & Immunochemistry, and Quantitative Microscopy & Image Analysis. It also administers the undergraduate Minor degree program in Biomedical Engineering. In June 1997 it sponsored, along with the School of Engineering and the Departments of Chemical Engineering and Biology and the Whitehead Institute the 2nd Annual Summer Course in Molecular & Cell Biology for Engineering Faculty. On the research front, it has organized a number of funding initiatives at the interface of engineering and biology aimed at federal, industrial, and foudnational agencies.

Douglas A. Lauffenburger

CENTER FOR ENVIRONMENTAL HEALTH SCIENCES

Faculty, students, and research staff are trying to discover if the agents in our environment which can cause genetic changes in human cells in the laboratory are also responsible for causing genetic changes leading to human diseases. Genetic diseases are of two kinds. Those arising from mutations in germ cells which are then observed as inherited diseases, or those which arise in the somatic cells of our organs where degenerative diseases or cancers are observed. Inherited genetic changes causing severe physical or mental impairment of our newborns approaches 2% and fills nearly half of the beds in our pediatric hospitals. Human cancers require several genetic changes (mutations) inherited or occurring within the organ from which the tumor arises. We hope to make substantial contributions to understanding basic mutational mechanisms, finding the causes of human mutations and defining the quantitative relationships that govern the lifetime occurrence of diseases which require multiple mutations in humans.

Mutations, cell kinetics and cancer.



COLON CANCER: Death Rate for Persons born in 1880s

Since cancer requires that a particular cell contain several separate genetic changes we undertook the development of a unified field model combining the number of such mutations and the rates of cell division and death in the tissue from which the cancer arises. If such a model were correct it would allow estimation of mutation rates and cell kinetic rates from the observed age-specific cancer mortality data. It would also allow calculation of the fraction of the population at risk of such a cancer. In 1997, we completed two tasks, the completion of the unified theory and ordering of U.S. mortality data and census data so that the cancer mortality rates could be observed for some cancers from 1900 to the present day. An example of an age-specific cancer mortality curve is shown above for colon cancer death.

Using the unified model and observations of cell death and division rates in normal and adenomas of the human colon we have been able to observe the historical increase in the number of Americans at risk of colon cancer and the mutation rates for each of three critical events in this process. Curiously, the estimates of mutation rates and cell kinetic parameters remained almost unchanged throughout the last century and a half while the number of persons at risk increased by about 66%. The estimated mutation rates are very close to those observed for spontaneous mutations in human cells grown in our laboratory, i.e. the rates are the same as seen in human cells that are not exposed to any environmental chemicals. Examination of the kinds and distribution of point mutations in the APC gene which must be mutated to begin the process in most colon cancers reveals that they are of a kind which might be expected to arise by the normal errors of DNA replication. Pursuing this point will be a major activity for the Center.

These data follow on our previous discovery that the number and pattern of point mutations in the mitochondrial DNA in human organs are essentially invariant. These patterns are the same in colon, muscle and bronchial epithelium. A striking finding has been that even cigarette smoking has no effect on the mitochondrial point mutations as demonstrated by our studies in lungs of identical twins discordant for smoking.

The development of technology to directly measure environmental chemicals and genetic change in humans has been our strongest area of contribution in recent years. We now need to invest in studies of cell turnover (the process of cellular renewal in all tissues), errors in the programming of which we believe are important in carcinogenesis. Fortunately, a new faculty appointment in the Division of Toxicology, Dr. James Sherley, addresses this need both in terms of research guidance and teaching. A distinct weakness of the Center, the Division of Toxicology and MIT genetic toxicology continues to be the absence of faculty who would focus on the important disease producing changes which involve rearrangement or losses of whole chromosomes.

We have developed technology which allows us to measure chemical reaction products with proteins and DNA in human tissue (NIEHS Biomarkers Program). We have studied chemicals entering humans from the environment: food in the Biomarkers Program, air in the Mutagenic Effects of Air-borne Toxicants Program, and water in the Superfund Hazardous Substance Basic Research Program. Unfortunately, we have not achieved a synthesis uniting the research which measures the human exposure in terms of DNA reaction products derived from environmental chemicals and the rate and kind of genetic changes. Indeed, the question may well be raised as to whether DNA adducts are precursors of a significant fraction of human genetic changes in either mitochondrial or nuclear DNA.

Yet, we in CEHS have never assumed that environmental chemicals constitute the primary causes of human genetic change however, we are well-positioned to follow up on the present observations. Two major programs, Endogenous Nitrite Carcinogens in Man (NCI) and Genetics and Toxicology (NIEHS), have focused specifically on either one powerful endogenous mutagen, NO, or the endogenous process of DNA replication to determine responsibility for our genetic change rate. We have cast a net to discover if the patterns of spontaneous mutations in bacterial or human cell studies are recapitulated in human tissues.

RESEARCH CORE GROUPS

The Air Quality Core has two components. The first is directed at identifying airborne chemicals found in human lungs, and relating these to their sources and atmospheric transformation processes. The second is to assess the potential human damage associated with the emissions from a variety of thermal processes proposed for remediation of Superfund sites. Professor Jack Howard of Chemical Engineering has become Associate Director for this core group after the retirement of Professor Adel Sarofim. Professor John Vander Sande joined this core group this Fall with the goal of extending his technology of x-ray fluorescence microscopy to identification of the sources of particulate matter in human lungs. A totally redesigned Program (Mutagenic Effects of Airborne Toxicants in Human Lungs) was proposed to the National Institute for Environmental Health Sciences on October 1, 1997 with a five-year budget of approximately 9 million dollars.

The Water Quality Core focuses on the behavior of toxic chemicals in the natural environment with particular emphasis on processes that lead to human exposure. The studies also work to determine the effectiveness of remediation technologies to attain high waste destruction efficiencies without the formation of mutagenic by-products from deposits such as found on Superfund sites. Professor Harold Hemond is Associate Director for this core group as well as head of the Parsons Laboratory, Department of Civil and Environmental Engineering.

Our Toxicology and Epidemiology Core focuses on discovering the causes of genetic change or other physiological conditions leading to human disease. We have developed technology which allows us to measure chemical reaction products with proteins and DNA in human tissue, and have also developed means to measure the point mutational spectra arising in the human mitochondrial genome. These twin technologies are now being used in parallel to try to discover the causes of mutations in people. The retirement of Professor Gerald Wogan and his replacement by Professor Steven Tannenbaum as head of the Division of Toxicology vacated the Associate Director's position long held by Professor Tannenbaum. He has now been replaced by Professor Peter Dedon, Associate Professor of Toxicology, who is already active in our nascent effort with microchip manufacturing faculty in several engineering departments.

We expect to compete for a specialized center in human genomics when announced as a joint effort of the National Institute of Environmental Health Sciences and the National Cancer Institute. This proposal will stand on the legs of our advances in analyzing public mortality records to identify populations depleted of inherited disease causing genes and our technology for recognizing DNA sequence changes which may be applied for scanning 1,000 persons' blood samples simultaneously.

We have been invited to join the new Microsystems Technology Lab to create a major program to assess the materials used and created within the semiconductor manufacturing industry. It is clear from initial discussions that the CEHS' approach to complex mixtures analysis for chemical identity and biological activity are a natural "fit" to the needs of faculty groups involved in the manufacturing process design.

CORE LABORATORIES

The Core Laboratory is a central resource in analytical chemistry for CEHS project participants, providing them with analytical expertise, training, and access to analytical instrumentation. A major goal of the CEHS is to foster collaborative research among combustion engineers, genetic toxicologists, analytical chemists, civil engineers and other investigators in order to solve important problems in human health effects research. The Core Lab is a centrally important resource in making this research collaboration come to fruition. It is headed by Dr. Arthur Lafleur who succeeded the retiring Professor Klaus Biemann as Associate Director for analytical chemistry. Dr. Lafleur is organizing a Boston area consortium of university laboratories with special interests and abilities in analyses of sources, environmental samples and human tissue samples. The goal is to increase our several universities efforts in environmental health and engineering to be more competitive in grant proposals and to offer a wider spectrum of analytical chemistry experiences for our MIT students necessitated by the abandonment of analytical chemistry as an academic area at MIT.

COMMUNITY OUTREACH

To promote broader public understanding of our methods and goals, CEHS has teamed up with the Massachusetts Corporation for Educational Telecommunications (MCET). MCET is a not-for-profit, distance-learning organization serving the needs of the K-12 community. It reaches an audience located in 47 states or approximately 1.3 million participants and every school district in Massachusetts. MCET has an annual budget of approximately \$9 million funded from various U.S. federal agencies, state agencies and corporations.

In 1996 we aired a highly successful pilot program for a six program series for middle school teachers and students that would increase understanding of how hypothesized connections between the environment and health are explored. The program highlighted the scientific processes used by researchers to prove or disprove hypothetical connections between the environment and disease. Afterwards, we prepared a proposal for a series of programs and submitted it along with the pilot video to the National Institute of Environmental Health Sciences. As a result, CEHS obtained full funding for the series. On 10 October 1997 we presented our first full length segment to some 45 Massachusetts high schools. Credit is given to Dr. Heidi Nepf, Assistant Professor in Civil and Environmental Engineering, for her leadership in this project. As second session is already "in the can" and a third will be completed by Thanksgiving.

HIRING AND RECRUITMENT PRACTICES

The CEHS supports the affirmative action goals of the Massachusetts Institute of Technology while maintaining our commitment to hiring solely on qualification of the candidate for the position. This year two of our feasibility studies by female junior faculty members went on to receive direct support as projects in our program grants. The majority of our staff, including research specialists and graduate students are women. Additionally, as has been the case in CEHS, we receive a Minority Supplement from NIEHS for support of a Research Assistant.

In 1996-97 the director identified and worked for the appointment of Dr. James Sherley, M.D, Ph.D (Harvard, Johns Hopkins) of the Fox Chase Cancer Center as an Assistant Professor in Toxicology. Dr. Sherley is an African-American and will occupy newly renovated CEHS office and laboratory space (bldg 16) ceded by CEHS.

William G. Thilly

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) funded training program for veterinarians specializing in laboratory animal/comparative medicine and conducts externally funded research focusing on comparative medicine. Total personnel in the Division now comprises 90 individuals. Plans are underway for the Division to move 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 final phase of major renovations in the animal facilities continued during FY97. Renovations to the eighth of Building 56 have just been completed and this space can now accommodate quarantine animals. The state-of-the-art animal facilities now include 30,000 gross square feet in Building 68, which has been occupied since November, 1994, and a fully renovated E17/E18 facility (13,200 gsf), which has been occupied since March, 1995. Also, a new addition of 11,300 net square feet to the Whitehead facility along with renovations to the existing animal area were completed this past year. These facilities support transgenic and gene "knockout" *in vivo* experiments. The average daily census of laboratory animals increased approximately 14 percent during FY97. Mice remain the primary species used by MIT investigators and represent more than 98 percent of the animal population.

Current NIH-funded grants support *in vivo* study of nitrite carcinogenesis, *in vivo* study of *Helicobacter hepaticus* carcinogenesis, *in vivo* study of the etiology of lymphoma in ferrets, *in vivo* studies of *H. pylori* pathogenesis and the role of *Helicobacter felis* and *H. mustelae* in inducing gastric cancer. Private pharmaceutical firms have provided funding for research on the efficacy of anti-*Helicobacter* agents and *H. pylori* pathogenesis studies. FY97 was the ninth year of the Division's NIH postdoctoral training grant. There are currently six postdoctoral trainees, two of whom were enrolled in graduate programs in the Division of Toxicology. One postdoctoral student received an MS in Toxicology and has been recruited to Stanford University. Another postdoctoral fellow has been recruited to the faculty of the Albert Einstein School of Medicine. Four former postdoctoral trainees passed the board examinations of the American College of Laboratory Animal Medicine.

DCM faculty and staff published three chapters, 24 papers and 23 abstracts in FY97 and presented numerous research papers at national and international meetings.

Recruitment is underway to replace two senior staff members. Karen McGovern, a Molecular Biologist and Charmaine Foltz, a Clinical Veterinarian, left this past year. Mark Schrenzel, DVM, PhD and an ACVP boarded pathologist has joined the Division as a Comparative Pathologist. DCM faculty and staff taught the graduate courses Toxicology 201 and 214.

Didactic training sessions were conducted throughout the year by DCM staff in conjunction with the Committee on Animal Care to train Institute personnel on topics pertaining to the care and use of laboratory animals. The Committee 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.

James G. Fox

DIVISION OF TOXICOLOGY

The Division of Toxicology is an academic unit of the Whitaker College of Health Sciences and Technology. Its major educational activity is the operation of a graduate degree program leading to S.M./Ph.D. degrees in toxicology. Teaching as well as research programs emphasize mechanisms through which chemical and physical agents in the environment induce toxicity and pathogenesis.

The objective of the programs of the Division is to train scientists who will be professionally qualified to make research contributions to improve understanding of the impacts of hazardous chemicals and other environmental agents on human health, and to educate future generations of scientists with similar interests and qualifications. Special emphasis is placed on development and application of *in vivo* and *in vitro* experimental models and approaches designed ultimately to elucidate, in cellular and molecular terms, mechanisms through which such agents induce their adverse effects. Strong emphasis is placed on the development, validation and application of methodology for detection and characterization of adverse effects that will improve assessment of hazards to humans resulting from environmental exposures. Utilizing biochemical, chemical and biological approaches, the training of pre- and post-doctoral trainees is concerned with: characterization of effects of toxic, carcinogenic and mutagenic chemicals at intact animal, tissue, cellular and molecular levels; development of methods for the detection and quantification of such effects in humans, experimental animals, and other experimental systems; studies of metabolic activation, macromolecular binding and genetic effects; and elucidation of modes of action at cellular and molecular levels.

FACULTY

Faculty members whose primary academic affiliations are in the Division include Professors Peter C. Dedon, Bevin Engelward, John M. Essigmann, Ram Sasisekharan, David B. Schauer, Steven R. Tannenbaum, William G. Thilly, and Gerald N. Wogan. James G. Fox, Director of the Division of Comparative Medicine also is a Professor in the Division of Toxicology. Professors Essigmann, Tannenbaum and Wogan hold joint appointments in the Department of Chemistry. Professor Thilly also serves as Director, and other Toxicology faculty form the nucleus of the Center for Environmental Health Sciences in Whitaker College of Health Sciences and Technology.

EDUCATIONAL PROGRAM

The Division offers a graduate degree program leading to Ph.D. or S.M. degrees in Toxicology. The curriculum is designed to provide rigorous training in basic sciences, with particular emphasis on graduate subjects in biochemistry, molecular biology and genetics as well as toxicology. Graduates of the doctoral program follow career paths in academic, industrial or governmental organizations requiring applications of modern methods of chemical, molecular biological and genetic analysis to research related to the evaluation of risks associated with chemical exposures. The scope of both educational and research programs encompasses subject matter pertinent to activities of chemical, biotechnology, pharmaceutical, and food industries, as well as to governmental regulatory and research agencies.

Students admitted into the degree program pursue a series of required and elective subjects that ordinarily require three semesters to complete. Following successful completion of comprehensive written and oral examinations, usually administered in the fourth term of study, students must submit and defend a thesis proposal not later than three semesters later. Thesis committees are comprised of three to five faculty members from the Division of Toxicology as well as other departments of M.I.T., Harvard or other institutions as required by the nature of the doctoral thesis research.

AFFIRMATIVE ACTION

Specific efforts to recruit members of underrepresented minority groups are made at several levels. In the context of general recruiting efforts, all notices and other documents clearly state the M.I.T. and program commitment to recruitment of minority candidates. Additional recruiting efforts include internships, faculty visits, conferences, mailings and informal networking by current minority trainees.

An important and most fruitful avenue of contact with prospective minority students has been through the M.I.T. Minority Summer Science Research Program (MITSSRP). This program was initiated in 1986 as an institutional

effort to address the issue of under-representation of African Americans, Hispanics, and Native Americans in mathematics and the physical and biological sciences in the United States. The Summer Science Program is designed to provide opportunities for talented minority sophomores and juniors to spend a summer on the M.I.T. campus working in an active research program under the guidance of faculty, postdoctoral fellows, and graduate students. The Toxicology faculty have consistently been active participants in the MITSSRP since its inception. This has proven to be an effective recruitment path, as approximately one-half of our current and formerly enrolled minority doctoral candidates were Summer Program interns before joining the Division. Unfortunately, only one intern was assigned to the Division of Toxicology in 1996 and 1997 due to the number of faculty throughout the Institute who volunteered to be MITSSRP mentors. The Summer Science Program interns receive advice and information about graduate study directly from their Faculty Sponsors, laboratory supervisors and the Division Academic Administrator.

Toxicology faculty are frequently involved in minority recruitment activities outside of M.I.T. Recent examples include attendance at the NIGMS Minority Programs Symposium, the Minority Access to Research Careers (MARC) Conferences, and personal visits to colleges that enroll large numbers of minority students in order to meet with prospective applicants and to develop contact with faculty members of science departments. Over the years, visits have been paid to Cayey College, the University of Puerto Rico and campuses of several Historically Black Colleges and Universities (e.g., Morehouse, Spelman, Clark Atlanta University, and Georgia Tech). During 1995, Prof. William G. Thilly and Ms. LaCreis R. Kidd visited the latter campuses. In addition, Prof. Gerald N. Wogan participated in a minority recruiting symposium held in conjunction with the Society of Toxicology annual meeting in March, 1996. In July of 1996, M.I.T. hosted the 3-day National Minority Undergraduate Research Symposium. Prof. Peter C. Dedon, the Toxicology Graduate Admissions/Registration Officer, along with two graduate students from his lab group, met with interested Symposium attendees, distributed literature, and participated in poster sessions. Most recently, Prof. David B. Schauer has been actively involved in recruiting under-represented minority students to the Division of Toxicology. In January of 1995, he attended the SACNAS (Society for the Advancement of Chicanos and Native Americans in Science) Conference in El Paso, Texas. Among other Conference activities, Prof. Schauer staffed an Exhibit Booth in order to meet with and distribute Division literature to potential applicants. In October of 1996, Prof. Schauer represented the Division and M.I.T. at the SACNAS Conference held in Los Angeles, Ca. In future years it is expected that these activities will continue to play an important part of the Division's recruiting efforts.

Two new minority students will join the Division in Fall, 1997. Cecilia Fernandez earned the B.A. Degree in biology from Boston University and Jose Marquez was an undergraduate in Civil & Environmental Engineering at M.I.T. In addition, there are four continuing students. Pablo Herrero was an undergraduate in Chemical Engineering at M.I.T. before joining the Division. Curtis Glover earned his B.S. degree in chemistry and biology at Cheney University of Pennsylvania and J. Christopher Goodwin attended the University of Maryland at Baltimore as a biology major. Jacquin Niles earned the S.B. degree in Chemistry at M.I.T. and is enrolled in the Toxicology Ph.D. program which he will complete in conjunction with the M.D./Ph.D. program at Harvard Medical School.

Two minority students recently completed their doctoral work. LaCreis R. Kidd was awarded the Ph.D. degree in June, 1997 and she has accepted a postdoctoral position at Johns Hopkin University School of Public Health. Deirdre Lawrence successfully defended her Ph.D. Thesis in Summer, 1997 and has been selected for a National Cancer Institute Cancer Prevention Fellowship. As a participant in this program, Ms. Lawrence will enroll in a Master's degree program at the Harvard School of Public Health in September. Upon completion of the S.M. degree, she will then conduct postdoctoral research for N.C.I.

Efforts to recruit members of underrepresented minorities into the Toxicology program are being conducted in coordination with institutional programs with similar objectives within M.I.T. For example, the Division is one of four academic units at M.I.T. participating in the Sloan Foundation Fellowship program which provides financial assistance to support the recruitment and funding of new minority graduate students. Both of our incoming new students, Ms. Fernandez and Mr. Marquez, will be supported as Sloan Foundation Fellows during their first year of graduate study. These efforts have been developed with the support of and in consultation with Isaac M. Colbert, Senior Associate Dean and Margaret D. Tyler, Associate Dean of the Graduate School of M.I.T. for minority student affairs.

FACULTY RECRUITMENT

One new faculty member has been identified for appointment to the Division for the coming year. Dr. James Sherley will join us in the Spring Semester of 1998 when the renovation of the Building 16 space is complete.

Dr. Sherley received his B.A. degree in Biology from Harvard University in 1980, and his M.D. and Ph.D. (Molecular Biology) from Johns Hopkins in 1988. This was followed by a postdoctoral period at Princeton University from 1988-1991 and then his position at Fox Chase Cancer Center from 1991 to the present. Throughout this period he received several awards and fellowships. His doctoral research dealt with defining the mechanisms involved in regulating the levels of replication proteins during the cell cycle with particular emphasis on human thymidine kinase. His postdoctoral research focused on the tumor suppressor p53 in which he developed novel approaches to understanding its biological function. He continued this work on p53 in his move to Fox Chase, where he observed that modest activation of p53 slows growth of cells that are growing exponentially. The new growth rate is linear, and the behavior of the cells shows the features of renewal growth, suggesting that increased p53 expression might effect a switch from symmetric to asymmetric cell division. This is very exciting because such switching genes must be critical for development, and because the multiple somatic events that are necessary for cancer in epithelial tissues can only accumulate in cells that both divide and have long lives.

HONORS AND AWARDS

The following honors and awards were accorded to faculty and students of the Division during the current academic year.

Prof. John M. Essigmann was named a MacVicar Faculty Fellow in the Margaret MacVicar Faculty Fellows Program, "in recognition of sustained and significant contributions to teaching and undergraduate education in the Institute". He also was awarded the 1996 School of Science Teaching Prize for Excellence in Undergraduate Education.

Prof. Steven R. Tannenbaum was awarded the Underwood-Prescott Professorship and was elected as a member to the Institute of Medicine of the National Academy of Sciences.

Prof. Ram Sasisekharan was appointed to the Editorial Board of the new journal *Angiogenesis*.

Mr. Jinghai Xu, a doctoral candidate in Toxicology working with Prof. Peter C. Dedon was awarded the *Whitaker Health Sciences Fellowship* for 1996-97 and 1997-98, which is awarded to one doctoral student in Life Sciences or Bioengineering annually.

Ms. Cecilia Fernandez, a doctoral candidate in Toxicology who is conducting her thesis research with Prof. Bevin Engelward and Mr. Jose Marquez, a Master's candidate with Prof. William G. Thilly, have been awarded Sloan Fellowships for the 1997-1998 academic year. These fellowships are intended to provide support for minority students, and are competitively awarded by Dean Isaac Colbert, of the Graduate Education Office.

Ms. Sophie Currier has been awarded an Ida Green Fellowship. This competitive award provides tuition and a stipend for the 1997-98 academic year. Ms Currier is an S.M. candidate in Prof. John M. Essigmann's lab.

Ms. Aoy Tomita was one of two recipients honored with the Poitras Fellowship for graduate students conducting research in the biomedical sciences. This prestigious fellowship includes tuition and stipend for the academic year, 1997-98.

More information about the Division of Toxicology can be found on the World Wide Web at the following URL: <http://web.mit.edu/tox/www/>.

Steven R. Tannenbaum

HARVARD-MIT DIVISION OF HEALTH SCIENCES AND TECHNOLOGY

The mission of the Harvard-MIT Division of Health Sciences and Technology (HST), established in 1970, is to develop and conduct research and educational programs across disciplinary lines within MIT and Harvard University, and the teaching hospitals in order to combine the sciences and engineering in the solution of problems in biology and medicine. By uniting the great strengths of the two universities, HST trains students for research and leadership roles in medicine, biomedical sciences and biomedical engineering. The program seeks to improve human health through its multidisciplinary, multi-institutional research and educational activities.

Recognizing that the future requires leaders who can effectively bridge the cultures represented by medicine, science, and engineering, the Division accomplishes its mission by providing truly multidisciplinary training in these three areas to both MD and PhD candidates. Accordingly, the HST student body and faculty have backgrounds and interests spanning the continuum represented by these areas, and have career and research objectives that depend on a substantial integration of these areas. The HST MD curriculum trains physicians who have a deep understanding of the underlying quantitative and molecular science of medicine and biomedical research. The PhD programs combine rigorous scientific or engineering graduate training with an in-depth exposure to the biomedical sciences and clinical medicine.

The research programs for students and faculty similarly reflect the mixing of cultures in applying the appropriate tools of medicine, engineering and science to address problems in human health and clinical medicine. They are focused on five main thematic areas:

- integrative molecular, cell, and tissue biology (quantitative physiology),
- biomedical engineering/biological physics,
- imaging sciences and technology,
- medical informatics, and
- clinical therapeutic discovery, delivery and assessment.

Through these programs, HST seeks to explore the fundamental principles underlying diseases, discover new pharmaceuticals and devices to ameliorate human suffering, and train the next generation of physicians, scientists, and engineers to do the same.

Because of its inter-disciplinary and inter-institutional nature, HST's administrative home at MIT is the Whitaker College of Health Sciences and Technology. The Division is headed by two Co-directors who report to J. David Litster, Professor of Physics, Vice President for Research, and Dean For Graduate Education, along with S. James Adelstein, Professor of Medical Biophysics and Executive Dean for Academic Programs at Harvard Medical School (HMS). Professor Martha L. Gray, Kieckhefer Associate Professor of Electrical Engineering is the M.I.T. Co-director, while Dr. Michael Rosenblatt, Robert Ebert Professor of Molecular Medicine, is the Harvard Co-director. Dr. Joseph Bonventre, Associate Professor of Medicine at HMS, serves as Associate Director of HST and Director of Student Affairs for HST-MD students.

During the 1996-1997 academic year, the directors and faculty considered a proposal from the Dean of Engineering, wherein HST would be administratively centered in the School of Engineering. After many meetings and long discussions, the HST Joint Faculty Committee approved a resolution stating that 1) It should be understood that the mission of HST will continue to be to develop and conduct research and educational programs across disciplinary lines among the schools of MIT, Harvard, and the teaching hospitals so as to bring to bear the physical sciences and engineering in the solution of problems in biology and medicine -in other words, to join together the great strengths of the two universities in the solution of problems in biology and medicine. and 2) that HST should continue to report directly to the office of the Provost at MIT and the Dean of Harvard Medical School.

HIGHLIGHTS OF THE YEAR

Mr. John Taplin, an MIT '35 alumnus, and his wife Virginia, have established a \$2 million fund to advance research, study, and training in HST. The fund will recognize and support the work of HST faculty and students in building HST's infrastructure in the areas of biomedical engineering, physics, and chemistry.

The first four recipients of John F. and Virginia B. Taplin Awards were announced June 4th at commencement ceremonies for the Harvard-MIT Division of Health Sciences and Technology. The four inaugural recipients of the \$50,000 awards are Elazer R. Edelman, M.D., Ph.D., class of '83 and the Thomas D. and Virginia W. Cabot Associate Professor of HST; Dennis M. Freeman, Ph.D., assistant professor of Electrical Engineering and Computer Sciences; W. Eric L. Grimson, Professor of Electrical Engineering and Computer Science; and Mehmet Toner, Ph.D., Class of '89 and associate professor of surgery and bioengineering, Harvard Medical School.

The keynote speaker for HST Commencement was David Ho, M.D., who was named Man of the Year in 1996 by TIME magazine for his widely acclaimed work in the battle against AIDS. The 1978 HST graduate stated that he would forever be indebted to the institution "where my clinical skills were honed, where my scientific research interests were solidified, and where I truly learned to tackle research with a multidisciplinary approach not limited by arbitrary boundaries that separate medicine from the physical sciences, engineering, and mathematics".

HST faculty will play an important role in the new National Space Biomedical Research Institute as part of an agreement signed with NASA on June 1. The 20-year agreement (five years with three 5-year extensions) is worth approximately \$145 million. The director of the Institute is Laurence R. Young, Ph.D., Apollo Program Professor of Aeronautics at MIT and a member of the HST faculty. Richard Cohen '76, an HST core faculty member, will be one of the project team leaders.

The second Follow-up Study of MD graduates of HST was published in June 1997 (W. H. Abelman, B. D. Nave and L. Wilkerson. "Generation of Physician-Scientist Manpower: A follow-up Study of the First 294 Graduates of the Harvard-MIT Program of Health Sciences and Technology," *Journal of Investigative Medicine* 1997; 45:1-4). Faculty appointments in 64 medical schools were held by 212 (75%). Overall, 73.5% were engaged in research: 68% of Mds and 86% of MD-PhDs. One hundred and four (38%) spent more than 50% of their time on research: 29% of Mds and 60% of MD-PhDs. Seventy-five per cent of respondents were actively teaching. Thus, the goal of the program to produce physician-scientists and leaders in academic medicine was reached.

Dr. Richard Cohen, Professor of HST, holds a patent on a technique used to identify persons at risk for sudden cardiac death. Proceeds from this technology will support a new Distinguished Professorship in Health Sciences and Technology.

HONORS AND AWARDS

Robert S. Langer, Sc. D., the Germeshausen Professor of Chemical and Biomedical Engineering at MIT and member of the HST faculty, was awarded the 26th Killian Faculty Achievement Award. The Killian Committee commented that "Bob is a world leader in the development of polymeric drug delivery systems that allow humans to receive drugs in a physiologically normal manner". George Benedek, Ph.D., Alfred H. Caspary Professor of Physics and Biophysics and a long-standing member of the HST faculty, received the Proctor Medal from the Association for Research in Vision and Ophthalmology. David Ho (HST MD '78) was named "Man of the Year" by TIME magazine.

PROGRAM HIGHLIGHTS

HST offers approximately 70 courses in the biomedical sciences and biomedical engineering, a number of which have been developed jointly with other MIT departments. More than 150 faculty members at MIT and at Harvard Medical School contribute significantly to the academic programs of HST. The Division has a "core" faculty numbering ten individuals (including the directors).

A total of 299 graduate students were registered in HST degree programs during the academic year. There were 186 MD candidates of whom 91 were simultaneously pursuing PhD degrees. HST doctoral programs registered 113 students: 78 in the Medical Engineering and Medical Physics (MEMP) track, 37 in the Speech and Hearing Sciences (SHS) track, and 4 in the Radiological Sciences Joint Program which is sponsored jointly by HST and the Nuclear Engineering Department.

Admission to programs continues to be extremely competitive, with about 400 applicants for 40 MD slots, 175 applicants for 10 MEMP slots, and 30 applicants for 7 SHS slots.

The MD degree was awarded by Harvard Medical School to 29 HST students this year, of whom five received honors in a special field and eighteen received the combined MD-Ph.D. degree. Thirteen students received MEMP doctoral degrees from MIT. One student received a doctoral degree from the Radiological Sciences Joint Program. One student received a Master of Science degree in Health Sciences and Technology.

RESEARCH ACHIEVEMENTS

An objective of HST from its inception has been to foster development of interdisciplinary, inter-institutional collaborative research between the faculties of MIT and Harvard. The research of the HST core faculty and research staff covers a wide spectrum of biomedical areas including: auditory physiology (including therapeutics); pathophysiology, epidemiology, and therapy of atherosclerosis (including diagnostic instrumentation); biological response of tissue such as cartilage to mechanical, chemical and electrical factors; regulation of gene expression; gene therapy; virus replication and assembly; hyperthermia for cancer therapy; biomedical instrumentation; tissue engineering; systems physiology and modeling; physiological signal processing; vascular biology and pathophysiology; and fundamental pathophysiology of bone. Their research links include a number of Harvard Medical School teaching hospitals (MGH, BWH, BIH, NEDH) and the Harvard Medical School quadrangle.

HEALTH HAZARDS FROM "EMF"

James C. Weaver, Senior Research Scientist, and colleagues at MIT, Yale and Chicago are carrying fundamental theoretical studies of the conditions under which weak electric and magnetic field (EMF) can alter biochemical processes, with the aim of clarifying the controversy regarding human disease and exposure to weak fields associated with the use of electrical power.

BIOMEDICAL ENGINEERING

H. Frederick Bowman, Senior Academic Administrator in HST and Director of the MIT Hyperthermia Program, reported the development of a needle embedded with microchips that can measure a variety of parameters, including temperature and oxygen levels, using a single device. The needle is 30% smaller in diameter than current probes and can be used for characterizing both normal and tumor tissues.

BIOMEDICAL PHYSICS

Richard J. Cohen, Professor of Health Sciences and Technology, is studying the electrical and mechanical regulation and stability of the cardiovascular system. Dr. Cohen's laboratory has developed a noninvasive means of identifying individuals at risk for dying of sudden cardiac death. Sudden cardiac death in adults results from disturbances of electrical conduction processes in the heart and is the cause of 300,000 deaths per year in the United States alone. The technology developed in Dr. Cohen's laboratory has now been successfully commercialized for clinical use.

BIOTECHNOLOGY AND TISSUE ENGINEERING

Lisa Freed, Research Scientist in HST and Gordana Vunjak-Novakovic, Research Scientist at Whitaker College are studying tissue formation using isolated cells, 3-dimensional polymer scaffolds, and bioreactor vessels. Ongoing research includes in vitro cultivation of cartilaginous and cardiac-like tissues, a recently completed 4 month microgravity experiment aboard the Mir Space Station, and the development and scientific testing of the cell culture facility for the International Space Station. These studies have significance for designing tissue engineering bioreactors and the production of functional tissue equivalents for clinical use.

Robert S. Lees, Professor of Health Sciences and Technology, and his colleagues, have recently been awarded a key patent for imaging the arterial tree with radiolabelled oligopeptides (short polymers of amino acids which resemble a small portion of a protein). This work was the first to show that short peptides could have the defined structure required to function in a way similar to the proteins after which they were fashioned to serve as diagnostic agents. The techniques developed in Dr. Lees's laboratory have been successfully incorporated into multiple diagnostic pharmaceuticals which are in clinical trial for imaging not only cardiovascular disease but also cancer and infection.

CENTER FOR EXPERIMENTAL PHARMACOLOGY AND THERAPEUTICS

This year, for the first time, graduates of the Clinical Investigator Training Program, a two year joint fellowship of HST and the Beth Israel-Deaconess Medical Center, received a Master of Science degree from Harvard Medical School. This unique program for clinicians, will, in the coming year, be joined by a parallel program for PhD's interested in applying their engineering, chemical, physical, or molecular science to problems of human disease. Funding has been secured for this program, and the first Fellows will enter the program in the coming year.

Research efforts have been centered on the application of quantitative measurements with such forms of technology as positron emission tomography, magnetic resonance imaging, and ultrasound to the process of drug development. In the fall of 1997, for the first time a course in drug development will be offered. This will be co-directed by Dr. Robert Rubin (HST), Dr. Stan Finkelstein (Sloan School), Dr. Tony Sinsky (Biology), and Dr. Charles Cooney (Chemical Engineering).

CLINICAL RESEARCH CENTER

Richard Wurtman, the Cecil H. Green Distinguished Professor, and Director of MIT's Clinical Research Center, now has a joint appointment in HST. Dr. Wurtman directs a basic-science laboratory that examines brain chemicals, - particularly neuro-transmitters and the molecular processes they control; he also carries out related human research within the Clinical Research Project. His current human studies involve: 1) the discovery that melatonin, a pineal gland hormone which his laboratory previously showed is secreted at night-time, normally controls sleep, and can be used to promote sleep (e.g., in older people, who often are melatonin-deficient); 2) the behavioral effects of exogenous Citicoline, a compound previously shown in this laboratory to promote the synthesis of membrane constituents (phosphatidylcholine) and of acetylcholine; and, 3) the use of nutrients which modify brain chemicals (like serotonin) to treat medically-undesirable weight gain and certain mood disorders.

MEDICAL INFORMATICS

Robert Greenes is the principal investigator for the Harvard-MIT-NEMC training program in medical informatics. This was competitively renewed this year for another 5 years. The review of the proposal by the National Library of Medicine received a stellar priority score. Participating groups in the renewed training program now include the Beth Israel Deaconess Medical Center and Children's Hospital, as well as prior participants at MIT, Harvard School of Public Health, New England Medical Center, Brigham and Women's Hospital, and Massachusetts General Hospital. The HST-based Masters program in Medical Informatics continues to grow, with 5 students now enrolled.

MEDICAL INSTRUMENTATION IN THE DEVELOPING WORLD

Dr. Stephen Burns has a long-term interest in the fate of medical instruments in the developing world. Specific issues include maintenance and repair and mechanisms for providing local technical expertise. In collaboration with the American Medical Resources Foundation, we have proposed a Center in the University of Hanoi to repair and up-grade medical instruments using modern computer technology. This involves understanding the instrumentation problem and replacing its original electronic control and display function with something ranging from a single-chip microcomputer to a locally procured personal computer. Mr. Neil Ghiso, HST-98, has upgraded a BEAR-3 respirator with a single-chip processor and traveled to Hanoi to design and initiate a study of current medical technology in Viet Nam. The respirator is an important technology, widely used, and dominated by air-handling hardware. The addition of a personal computer allows much more complex data-dependent control as well as providing quantitative measurement and data storage and retrieval; in summary--an upgraded instrument.

MICROBIOLOGY AND MOLECULAR GENETICS

Lee Gehrke, Lawrence J. Henderson Associate Professor, is studying RNA-protein interactions in the context of virus replication and assembly. His laboratory identified a single amino acid that enables a viral coat protein to bind RNA specifically. These findings have significance for understanding mechanisms of virus replication and particle assembly.

MOLECULAR BIOLOGY OF HEMOGLOBIN SYNTHESIS AND HUMAN GENE THERAPY

Irving M. London, Professor of Health Sciences and Technology and Professor of Biology, Emeritus, is studying the regulation of hemoglobin synthesis at both transcriptional and translational levels. His laboratory has discovered and characterized the main enhancer elements that control the transcription of the human β -globin. In collaboration with

Dr. Philippe Le Boulch of the Harvard Medical School faculty, he is also focusing on novel gene transfer strategies for the gene therapy of human diseases.

MRI IMAGING FOR ASSESSING CARTILAGE PHYSIOLOGY

Professor Martha Gray's research activities this year have centered on the use of magnetic resonance for measuring composition and functional integrity of cartilage. The fixed charged density of cartilage is one of the most important factors in reflecting the mechanical integrity of cartilage. Our NMR methods have exploited the fact that there is a quantitative relationship between the concentration of fixed charge and the concentration of ions in the tissue fluid. It is the concentration of these ions that we measure using MRI in order to infer functional integrity. With our new approach we have been able to identify focal lesions in intact joints and small explants of cartilage. The recent pilot studies suggests this method may be feasible clinically and in animal models. Thus, this approach has the potential to provide the unprecedented opportunity to nondestructively monitor disease progression and evaluate therapeutic efficacy.

REGULATION OF GENE EXPRESSION

Jane-Jane Chen, Principal Research Scientist, studies the regulation of hemoglobin synthesis by the heme-regulated eIF-2 alpha kinase (HRI) that is responsible for the translational regulation by heme of globin synthesis. Dr. Chen's group has demonstrated that HRI is a hemoprotein with two distinct types of heme binding sites. These data have significance for further understanding of the role of HRI in the production of hemoglobin, a vital oxygen carrying protein.

VASCULAR BIOLOGY, TISSUE ENGINEERING

Elazer R. Edelman is studying how the physical contiguity of cells and adjacent tissues contributes to autocrine and paracrine modes of growth control. In particular he has used elements of pharmacology, cell and molecular biology and biochemistry, high resolution microscopy and computer-based image analysis, finite element analysis, and tissue engineering to examine the communication between the endothelial and smooth muscle cells of the blood vessel wall. He and his students have demonstrated that disruption of the normal regulation these two cells impose on each other is the hallmark of accelerated proliferative vascular disease. These diseases now account for more morbidity and mortality than all other diseases combined.

PERSONNEL

Elazer Edelman, M.D., Ph.D. was appointed Associate Professor of Health Sciences and Technology at M.I.T., with tenure. Dr. Edelman is an expert in the area of cardiovascular biology. Professor Nelson Kiang retired in September 1996.

FUTURE PLANS

The main focus for the upcoming year is to aggressively reach out to the Harvard and MIT communities for involvement as we continue to build the infrastructure associated with HST's five main programmatic areas:

- integrative molecular, cell, and tissue biology (quantitative physiology),
- biomedical engineering/biological physics,
- imaging sciences and technology,
- medical informatics, and
- clinical therapeutic discovery, delivery and assessment.

These coupled, ongoing activities involve many of our students and faculty, and each offers the opportunity for participation by individuals from many departments in the MIT and Harvard communities.

The overall effort is aided significantly by the generous Taplin award program. Brief remarks concerning the focus areas follow:

Integrative molecular, cell, and tissue biology (quantitative physiology): This area encompasses the research of a great majority of our students, and it evolves naturally from their scientific interests and coursework. Our efforts have matured to the point that there is an opportunity for integrative educational and research initiatives. The Speech

and Hearing Sciences Program is tangible evidence of our early accomplishments. Building in this area will be a major goal of the graduate committee.

Biomedical engineering/biological physics: Two initiatives launched during the 96-97 year will continue to strengthen biomedical engineering in the coming year. The multi-institutional consortium entitled CIMIT (Center for innovative minimally invasive therapies) seeks to bring investigators from MIT, MGH, and BWH to develop technologies for medical applications. The MIT home for this activity is the HST Biomedical Engineering Center for Instrumentation, headed by Prof. Elazer Edelman. The NASA Institute, NSBRI (National Space Biomedical Research Institute) is a multi-institutional consortium whose mission is to understand the physiological consequences of space flight and to develop adequate countermeasures to allow human travel to Mars. Biomedical Engineering is a major element of the educational and research opportunities offered therein.

Imaging sciences and technology: About 30 faculty from Harvard and MIT have been actively involved in developing a coherent program for graduate and medical students and postdoctoral fellows. We plan to formally launch this program during the 97-98 year. We are in the process of recruiting a faculty member to provide a geographic locus for biomedical imaging at MIT.

Medical informatics: For several years, HST has served as the academic home for a training grant in Medical Informatics. The goal for the coming year is to explore ways to leverage the current activities in medical informatics for the mutual benefit of the training grant participants and HST. Participating faculty from MIT and Harvard Medical School include Dr. Robert Greenes (Harvard Medical School, and PI of the training grant) and Peter Szolovitz (Electrical Engineering and Computer Science).

Clinical therapeutic discovery, delivery and assessment: For several years the Clinical Research Center has been administratively linked to HST. With Prof. Robert Rubin's appointment to our faculty and the implementation of the Clinical Investigator Training Program, the interactions between HST and the CRC have become more substantial. The objective in the coming year is to work together to increase the number of faculty conducting research in the CRC, to involve CRC faculty in HST teaching, and to evaluate the opportunities for human research that could be promoted and facilitated by the CRC/HST.

Martha L. Gray

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. It was anticipated that in spite of its university venue, a large enough number of qualified physicians 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 and the CRC Advisory Committee before they can be implemented. The CRC Advisory Committee, chaired by Dr. John Burke, Professor of Surgery at the Harvard Medical School, consists of ten voting members plus six non-voting members of the CRC's program staff. The Committee reports to the Principal Investigator, Martha Gray, Professor and Interim Director of Health Sciences and Technology (HST), and meets bimonthly to evaluate protocols for their scientific quality, experimental design, statistical analysis 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 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. Arnold Weinberg, the Director of the Medical Department. Members of the CRC participate in the Medical Department activities; i.e., Quality Assurance, Pharmacy and Therapeutics, Medical Records, and Safety Committees.

The CRC received a grant award from the NIH for continuation of funds for the next four-year project period beginning in December 1996.

EDUCATION

The CRC has continued to provide postdoctoral training for physicians who are participating in fellowship programs at MIT. These physicians have utilized the CRC's facilities to initiate research protocols and to participate in ongoing projects supervised by senior investigators and faculty. During the current fiscal year, six postdoctoral fellows and four graduate students participated in research projects at the CRC. At the undergraduate level, thirteen Undergraduate Research Opportunities Program students participated in clinical research projects with physician preceptors and faculty supervisors.

AFFIRMATIVE ACTION

The hiring of women and minorities continues to be a high priority at the CRC; our primary problem in meeting affirmative action objectives has been attracting qualified minority candidates. The traditional means of advertising and posting positions in local colleges, universities, medical institutions, and minority organizations have not resulted in a significant response from qualified minorities.

This past year five research staff positions became available. Five women were hired, two minorities. Eight Visiting Scientists were appointed, two women and one male. The Center will continue its efforts to increase the pool of qualified minority applicants as positions become available.

RESEARCH ACTIVITIES

During the past year, most of the research activities of the CRC have continued to be associated with three clinical areas, and to involve three groups of scientists, 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), studies on the effects of drugs, foods and hormones on brain composition and behavior; studies on melatonin and sleep, and on biologic rhythms in sleep and hormone secretion; studies on 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 of Brain and Cognitive Sciences), focussing on the effects of diseases on cognitive and related brain functions and on genetic and other mechanisms causing neurodegenerative disorders (i.e., Alzheimer's disease). Groups collaborate on multi disciplinary projects, e.g., obesity; depression; Alzheimer's disease. Moreover, numerous CRC research collaborators involve both an MIT professor and investigators at an outside hospital or research laboratory.

This year the CRC patient census totaled 486 inpatient days and 2,933 outpatient visits.

CLINICAL INVESTIGATOR TRAINING PROGRAM

This year, for the first time, graduates of the Clinical Investigator Training Program, a two year joint fellowship of HST and the Beth Israel-Deaconess Medical Center, received a Master of Science degree from Harvard Medical School. This unique program for clinicians, will, in the coming year, be joined by a parallel program for Ph.D.'s interested in applying their engineering, for this program, and the first Fellows will enter the program in the coming year.

CENTER FOR EXPERIMENTAL PHARMACOLOGY AND THERAPEUTICS

Research efforts have been centered in the application of quantitative measurements with such forms of technology as positron emission tomography, magnetic resonance imaging, and ultrasound to the process of drug development will be offered. This will be co-directed by Dr. Robert Rubin (HST), Dr. Stan Finkelstein (Sloan School), Dr. Tony Sinskey (Biology), and Dr. Charles Cooney (Chemical Engineering).

COMPUTER FACILITY

The computer area focused on the development of the CRC Operations System. It is being developed using the ORACLE relational database, and supports the day-to-day operations of the Center.

Researchers continued to make use of the SAS statistical software available on the CRC computer system. They also began using the resources available on the Internet.

The computer facility is now independent of both the VAX and PDPN systems. It provides administrative report support and statistical assistance to all researchers. Design of the system fully integrates web services with the local database.

CORE LABORATORY/MASS SPECTROMETER FACILITY

The Core Laboratory specializes in assays that directly support the research efforts of CRC investigators. The most important and complex assays are undertaken by the Mass Spectrometer Facility, where stable isotope tracer analyses are performed. The Mass Spectrometer 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 signal transducer nitric oxide. The novel doubly labeled water ($^2\text{H}_2^{18}\text{O}$) 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.

High performance liquid chromatography (HPLC) techniques are also utilized by the Core Laboratory. 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 catecholamine and cytidine.

RESEARCH HIGHLIGHTS

Suzanne Corkin, Ph.D. and her colleagues showed that in young normal subjects, the hippocampus, parahippocampal gyrus, angular and fusiform gyri, show increases in functional magnetic resonance imaging (fMRI) signal during novel picture encoding (Stern et al., 1996), while the left and right prefrontal cortices are activated selectively during picture recognition (Stern et al., 1994). Corkin's project predicted, therefore, that high-performing older normal subjects and high-performing Alzheimer's Disease subjects would show similar activations.

The imaging methods were: whole brain fMRI using BOLD contrast, 1.5 Tesla GE scanner with ANMR EPI upgrade, 3x3x7mm voxels, and twenty coronal slices. The encoding data were collected during two novel picture blocks and two familiar picture blocks per four minute run. The recognition data were collected during two picture recognition (old/new) blocks and two picture identification (indoor/outdoor) blocks per four minute run. Data analysis used the Kolmogorov-Smirnov test.

During encoding, activation in older normal subjects resembled that seen in young normal subjects, but the presence of activation was not as consistent across subjects. The pattern of signal change for the Alzheimer's Disease group resembled that for the older normal subjects. Hippocampal activation during encoding was associated with good recognition memory scores, further suggesting that the hippocampus is essential for encoding.

The older normal subject recognition data replicated the young normal subject data. Most Alzheimer's Disease subjects, however, failed to activate prefrontal cortex, and when they did, the activation was weak and diffuse. The similarity between the older normal subjects and Alzheimer's Disease groups in (a) patterns of activation during encoding, and (b) recognition scores suggests that the failure to activate prefrontal cortex constitutes an important difference. These data suggest that differing fMRI activation patterns distinguish early Alzheimer's Disease from older normal subjects, and indicate a potential clinical application for fMRI in the diagnosis of Alzheimer's Disease.

William H. Dietz, M.D., Ph.D. and his coworkers continue to study a large cohort of girls whose energy expenditure and activity levels were measured at study entry. At the time the girls entered the study they were ten years old. Their average age is now fifteen years. In the last year, the investigators demonstrated that reported vigorous activity appeared to be an important determinant of the serum levels of low density lipoprotein cholesterol (LDL-cholesterol). This finding suggests that although the total energy spent on activity may affect susceptibility to obesity, the type of activity may have a bigger impact on other risk factors for cardiovascular disease, such as LDL-cholesterol. In a separate series of studies, the investigators showed that as girls got older, the accuracy with which they reported their dietary intake increased. This finding demonstrates again that use of dietary intake to determine energy requirements may not be valid, although dietary records may be useful to understand patterns of food intake.

Paul A. Spiers, Ph.D., and Gail S. Hochanadel, Ph.D., ended their study on the effects of Citicoline in more chronic patients after ischemic stroke. The results from a pilot group of patients suggested that there is a positive effect of the drug in this population as well as in normal elderly. This pilot research is being prepared for submission to the 1998 joint meeting of the American Neuropsychiatric Association and Behavioral Neurology Society.

Additional research projects examine the effects of Citicoline on memory in elderly patients with Age-Associated Memory Impairment, a condition which is widely considered to be a precursor of dementia, and the effects of phytoestrogen on the physical, emotional, and verbal memory disturbances associated with the menopause. (Phytoestrogen is the natural plant source of estrogen, and is abundant in soy.)

In June of this year, Drs. Spiers and Hochanadel had a poster presentation at the annual scientific symposium of the Massachusetts Neuropsychological Society. This poster, *Citicoline Improves Recovery after Traumatic Brain Injury*, dealt with two cases of high-functioning individuals who were treated with Citicoline on a compassionate use basis, under FDA guidelines, after they had suffered closed head injuries. In one case, the injury was mild but in the other (in fact, Dr. Spiers himself) the injury was extremely severe. Both cases had excellent recoveries, compatible with other European and American research using this drug with such patients. This report has also been submitted to the 1998 joint meeting of the American Neuropsychiatric Association and Behavioral Neurology Society.

Judith J. Wurtman, Ph.D. and her colleagues showed that weight gain among normal weight women undergoing a three month smoking withdrawal program can be minimized by treatment with dexfenfluramine although withdrawal of the drug following a three month treatment regimen causes weight to be gained. Fluoxetine treatment minimized weight gain for the first month of treatment; subsequently, weight gain among the fluoxetine treated group was similar to placebo and continued after the end of drug treatment. They also demonstrated that patients with obsessive compulsive disorder describe patterns of snack intake that include daily consumption of carbohydrate-rich snacks and self-reports of eating such foods when distressed. When their snacking habits were compared with a control population of patients attending a dermatology clinic, the snacking habits of both males and females with obsessive compulsive disorder were significantly different from the control group and was not related to either gender or weight status.

Richard J. Wurtman, M.D. and his co-workers demonstrated for the first time, that very low melatonin doses (0.1 or 0.3 mg), which raise daytime blood melatonin levels only to those which occur normally at night, make people sleepy and facilitate sleep initiation. The results obtained in twenty healthy people also suggest that the *normal* secretion of melatonin, each evening and night, is partly responsible for physiological sleep. In subsequent studies using low melatonin doses given later in the evening, using standard polysomnography, demonstrated that low melatonin doses at *all* of the time points tested cause sleep onset without disturbing the normal sleep structure. They additionally showed that melatonin administration causes no differences in mood and performance of people tested on the morning after melatonin or placebo. These preliminary results suggest that induction of melatonin concentrations close to normal physiological levels does not negatively affect humans' performance and mood the morning following treatment.

Vernon R. Young, Ph.D., D. Sc., was recently honored with a Doctor of Medicine (h.c.) from Uppsala University, Sweden.

Dr. Young and his colleagues earlier demonstrated the feasibility of using a whole body amino acid balance technique using ¹³C-labeled amino acid tracers to estimate human amino acid requirements. This novel approach opened the way for a reappraisal of the requirements for the nutritionally essential amino acids in human nutrition. Studies have been concerned with leucine, phenylalanine and lysine as the test amino acids. These studies by Young and coworkers have received international acclaim and have resulted in a profound change in concepts regarding the quantitative significance of the dietary amino acid intake level on human well-being. He is now initiating a collaborative study in Bangalore, India to assess the relevance of there findings from his MIT studies to healthy populations in the Third world.

Dr. Young was recently honored with a Doctor of Medicine (h.c.) from Uppsala University, Sweden.

Richard Wurtman

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.

Since all the faculty involved in the Joint Program are members of an academic department at MIT, their individual accomplishments and awards are reported through those departments. These include Courses I, II, VI, VII, XII and XIII.

There were 166 applicants to the Joint Program for 1997-98, of which 46 were admitted. We continue to maintain our high acceptance statistics: 70 percent of all applicants offered admission accepted. Women comprise 50 percent of the entering class, which is a new record for the Program.

Enrollment in the Joint Program decreased slightly this year from 146 to 137 students. The projected enrollment estimate for September 1997 is 141 students, with 18 in Chemical Oceanography, 26 in Marine Geology and Geophysics, 36 in Biological Oceanography, 28 in Applied Ocean Science and Engineering, and 33 in Physical Oceanography. The downturn in enrollment reflects uncertainty as to the exact consequences of direct charging for graduate students on research proposals.

The Joint Program graduated 22 students in 1996-97; of these, 14 received the doctorate, and eight received the master's degree. The breakdown by discipline is as follows: Chemical Oceanography (three); Biological Oceanography (two); Marine Geology and Geophysics (five); Physical Oceanography (seven); and Applied Ocean Science and Engineering (five).

We anticipate that there will be an external review of the Joint Program in the fall of 1997, as a follow-up to the Internal Review which was conducted in 1994.

More information about this Program can be found on the World Wide Web at the following URL:
<http://web.mit.edu/mit-who/ww>.

Ronni Schwartz

TECHNOLOGY LICENSING OFFICE

The mission of the Technology Licensing Office (TLO) is to facilitate the transfer of technology from MIT (and the Whitehead Institute) to industry, 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 26 (11 licensing professionals and 14 administrative and support personnel) are responsible for identifying marketable technologies, managing the patenting and copyrighting of these technologies, finding licenses to develop the technologies and negotiating licenses.

This was a record-breaking year for the Technology Licensing Office, with income of \$21.2 Million, of which \$5.7 Million was cash-in of equity. (The previous record year was FY '92, with \$16.2 Million, of which \$8.9 Million was cash-in of equity.) The remaining \$15.0 Million of non-equity-related income in FY '97 was a very substantial increase over FY '96 of \$10.2 Million.

The increase was due to a number of major events, in addition to continuing business, including cash-in of equity in three startup companies and substantial increases in royalties from several products on the market.

We consummated 59 new technology licenses, and 11 new option agreements. We currently have 455 active licensees. We also sold 96 end-use software licenses and signed up 20 new trademark licensees in FY '97, and started 8 new companies.

With 455 active licenses in house and about 115 startup companies extant (with equity in about 25 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 constant at about 350 per year (359 in this fiscal year), refilling the pipe line.

TLO staff are also active contributors to student activities at MIT. These include participation in the "50K" student business plan contest, guest lectures on patents and licensing in a number of Engineering, H.S.T. 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.

Senior TLO staff also served pro bono on the boards or senior committees of a number of state, national and local entrepreneurial and tech transfer organizations.

They have served (usually pro bono) as advisors to over a dozen university or governmental technology transfer officers in the U.S., Brazil, Hungary, Argentina, Taiwan, Japan and Germany, in addition to hosting literally dozens of visits from other such organizations and corresponding company departments in our own offices.

More information about the Technology Licensing Office can be found on the World Wide Web at the following URL: <http://web.mit.edu/tlo/www>

Lita Nelsen

CENTER FOR MATERIALS SCIENCE AND ENGINEERING

In September of 1994, the Center for Materials Science and Engineering (CMSE) at MIT was awarded one of the first National Science Foundation Grants under the new Materials Research Science and Engineering Center (MRSEC) program. After a second competition in 1996, the MRSEC grant at MIT remains the largest of the 24 at universities throughout the nation. We describe below the mission of CMSE and the methods used to reach its goals.

MIT has an extraordinarily strong and broad effort in materials science and engineering involving approximately 110 faculty members in 11 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 encourage 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. 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, wish to 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 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.

During the past year, CMSE has begun to prepare for the next MRSEC competition, beginning in September, 1997. An internal competition has been held to determine what IRG's will be proposed. Of the nine candidate groups, five will be chosen for inclusion in the new proposal. Several new groups, initially supported with seed funds, have emerged as outstanding candidates.

INTERDISCIPLINARY RESEARCH GROUPS

MICROPHOTONIC MATERIALS AND STRUCTURES

The purpose of this program is to explore the fundamental nature, synthesis, and properties of Photonic Band Gap (PBG) materials and to exploit these properties for the creation and control of electromagnetic radiation. These materials are a composite of a periodic array of macroscopic dielectric scatterers in a homogeneous dielectric matrix. A PBG material affects the properties of traveling electromagnetic waves in much the same way that a crystal of atoms affects the properties of electron waves. Consequently, photons in PBG materials can have band structures, gaps, localized defect modes, and surface modes. By allowing the trapping, localization, and channeling of light with very low loss, these new materials have the potential of completely revolutionizing the basic elements of photonic and optoelectronic integrated circuits. The bending radius of a conventional planar waveguide is limited to 1 cm by scattering losses; this geometry is incompatible with integrated photon distribution on a chip. A PBG material will allow a 10 μm radius bend, and provide a gateway to microphotonics. The research addresses a broad range of fundamental issues in novel synthesis pathways for in homogeneous microstructures, new photonic phenomena, and components for well-defined systems applications. The group has recently fabricated and characterized a one-dimensional PBG material consisting of a set of collinear air holes in Si. By omitting one of the lasers.

Participating faculty and departmental affiliations: Professors H. A. Haus, E. P. Ippen, L. A. Kolodziejski, and L. R. Reif (Electrical Engineering and Computer Science); E. R. Brown (Lincoln Laboratory); L. C. Kimerling (Materials Science and Engineering); and J. D. Joannopoulos (Physics).

MOLECULAR AND SUPERMOLECULAR ENGINEERING OF POLYMERIC SYSTEMS WITH NOVEL ELECTRONIC AND OPTICAL PROPERTIES

The objective of this group is to develop the chemistry and molecular-level processing needed to control and manipulate the molecular and supermolecular organizations of macromolecular systems with novel electrical and optical properties. The development and utilization of combined molecular/supermolecular engineering schemes will make it possible to design and fabricate complex, multiphase or multicomponent systems with controllable molecular architectures and well-defined morphological arrangements. Thus, it will be possible to create multi-component systems in which each component serves a well-defined function and is molecularly positioned to achieve a specific and tunable electrical, optical, or chemical response. The juxtaposition of different components, such as semiconductor nanocrystallites and conjugated polymers, may result in new and useful electronic and optical behavior. Applications of interest include highly anisotropic electrically conducting films, photonic devices, periodic dielectrics, and thin film electroluminescent and energy storage devices. This group has recently discovered a new way of making light-emitting polymer films and super-paramagnetic films that may be useful in security applications.

Participating faculty and departmental affiliations: Professors 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).

PHASE BEHAVIOR IN THE PRESENCE OF QUENCHED RANDOMNESS AND FRUSTRATION

Cooperative behavior in the presence of frozen-in randomness, i.e. ordering in the presence of quenched disorder, permeates all of materials science. Whereas phase changes in perfect systems are well-understood, the disorder challenges our ability to understand even qualitative effects and to make precise predictions and measurements. Cooperative phenomena in the presence of quenched randomness may also underlie fundamental mechanisms of life sciences and have applications to information sciences in, for example, neural networks or coding-decoding processes. The chief focus of this group is the study of gels with random distributions of positive and negative charges.

Participating faculty and departmental affiliations: Professors C. W. Garland (Chemistry); and A. N. Berker, R. J. Birgeneau, M. Kardar, and T. Tanaka (Physics).

STRUCTURE, CHEMISTRY, AND TRANSPORT PROPERTIES OF INTERCRYSTALLINE INTERFACES

The properties of polycrystalline materials are largely dominated by their surfaces and grain boundaries. For example, TiO_2 is the primary component in paint that makes it opaque, and the yellowing of paint in the presence of sunlight is an example of an interface effect that costs society great sums. However, these same photochemical reactions make TiO_2 useful for degradation of sewage. The goal of this IRG is to develop a unified and comprehensive understanding of the role of atomic level structure, chemistry, and local electronic structure in determining the physical properties of crystal interfaces. This group has recently demonstrated a correlation between the chemistry and electrical properties of interfaces in ZnO varistor material.

Participating faculty and departmental affiliations: Professors G. Ceder, Y.-M. Chiang, H. L. Tuller, and J. B. Vander Sande (Materials Science and Engineering); and J. Ying (Chemical Engineering).

TRANSITION METAL OXIDES

The discovery of high-temperature superconductivity in copper oxides has renewed interest in the more general problem of transition metal oxides, where strong correlations between the electrons are known to play a key role. For example, the parent compound La_2CuO_4 is an antiferromagnetic insulator, contrary to the prediction of band theory, and becomes metallic and superconducting when doped. Many believe that the superconductivity is a new manifestation of the correlated behavior of the electrons in the two-dimensional copper oxide layers. It follows that

the physics of strong correlations must be better understood before the superconductivity can be explained. The goal of this group is, therefore, to study the properties of transition metal oxides in order to guide the development of a theory of correlated systems and ultimately explain the mechanism of high-Tc superconductivity. The group's strategy for reaching its goal has three parts: detailed studies of the magnetic, electronic, and optical properties of single crystals, development of a theoretical framework for the analysis of the data, and a search for new compounds. The growth of large single crystals for neutron scattering experiments is a unique strength of this effort. Using these crystals the group recently discovered the spatial ordering of oxygen used to dope La₂CuO₄.

Participating faculty and departmental affiliations: Professors R. J. Birgeneau, M. A. Kastner, T. Imai, and P. A. Lee (Physics).

INITIATIVES

MICROSTRUCTURE AND MECHANICAL PERFORMANCE OF POLYMERIC MATERIALS

The research focuses on identifying the mechanistic connections between structure, morphology, and macroscopic properties of polymers. The project aims at establishing the fundamental connections between polymer microstructure and mechanical performance, and the design of new forms of heterogeneous polymer systems. This group has made a breakthrough in the toughening of polyethylene.

Participating faculty and departmental affiliations: A. S. Argon, M. C. Boyce, and D. M. Parks (Mechanical Engineering); G. C. Rutledge and R. E. Cohen (Chemical Engineering).

MULTISCALE MATERIALS MODELING FROM THE ELECTRONIC STRUCTURE-ATOMISTIC LEVELS

This program seeks to couple current techniques in ab-initio electronic structure calculations with Monte-Carlo based simulations in order to relate quantitatively the microscopic information on local bonding and chemistry to the kinetics of defect mobility and microstructural evolution. First-principles quantum mechanical methods and atomistic and mesoscopic simulations will be applied to develop a quantitative description of dislocation nucleation and mobility on epitaxial semiconductor films in order to provide a sound modeling tool.

Participating faculty and research staff and departmental affiliations: T. A. Arias (Physics); Dr. V. Bulatov (Mechanical Engineering); and S. Yip (Nuclear Engineering).

ELECTRONIC TRANSPORT IN MESOSCOPIC SYSTEMS

This initiative exploits new capabilities for processing of mesoscopic systems, including self-assembled arrays of semiconductor quantum dots and the fabrication of mesoscopic structures in Ge/Si. The group will study electronic transport in these systems to better understand the fundamental physics of these systems. In addition, the effects of GHz to THz radiation on the conductance of mesoscopic structures will be studied with an eye to possible applications.

Participating faculty and departmental affiliations: R. Ashoori, M. A. Kastner, P. Lee, L. Levitov, X.-G. Wen (Physics); M. G. Bawendi (Chemistry); E. A. Fitzgerald (Materials Science and Engineering); and Q. Hu (Electrical Engineering and Computer Science).

SEED PROJECTS

During the past year CMSE has supported the following seed projects:

- Ab Initio Study of the Properties of Materials on the Nanoscale, T.A. Arias (Physics)
- Investigations of Spin Diffusion and Local Ordering by High Resolution Scattering, D. G. Cory (Nuclear Engineering)
- Investigation into Nonwetting Phase Entrapment During Fluid Transport in Porous Media, P. J. Culligan-Hensley (Civil and Environmental Engineering)
- Design and Synthesis of Thermoplastic Elastomers with Side Chain Liquid Crystalline Soft Segments, P. T. Hammond (Chemical Engineering)
- Polymer Gel Actuators and Sensors, S. B. Leeb (Electrical Engineering and Computer Science)

-
- Gels for Molecular Recognition, Accumulation, and Release, S. Masamune (Chemistry)
 - Conductive Ladder Polymers: Pre-Assembly in the Synthesis of Complex Supramolecular Materials, T. M. Swager (Chemistry)

MATERIALS EDUCATION, HUMAN RESOURCE DEVELOPMENT, AND OUTREACH

CMSE's programs contribute to the education of both undergraduate and graduate students in a variety of ways. The CMSE colloquium series has provided an opportunity for graduate students from many departments to learn about the broad range of research activities at MIT. A joint program with the Materials Processing Center (MPC) brings students from all across the nation to MIT in the summer to become involved in materials research. The SEFs are also important in undergraduate education. Courses, such as those in X-ray scattering and electron microscopy, teach the 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. In addition to those involved in the IRGs, the shared facilities are used by graduate students from 11 academic departments.

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.

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. During the past year, CMSE facilities have been utilized by 26 commercial organizations and 11 outside academic institutions. The current CMSE/IBM X-ray participating research team (PRT) at the National Synchrotron Light Source (NSLS) at Brookhaven, the CMSE/IBM/McGill PRT under construction at the Argonne Advanced Photon Source (APS), and the Brookhaven/CMSE/AT&T/Exxon neutron scattering PRT at the Brookhaven High Flux Beam Reactor are very special facilities constructed and operated with direct industrial and government laboratory collaboration. These PRTs and the neutron diffraction PRT at the National Institute of Standards and Technology (NIST) provide time for use of facilities to users from all sectors. A new grant from the DoE has made possible the purchase of magnets to carry out neutron and x-ray measurements at fields that had been previously inaccessible. Finally, 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.

AFFIRMATIVE ACTION

CMSE is committed to providing opportunities to women and minorities through hiring and educational and research programs. During the past year, we hired one African-American woman, and promoted one woman and three men. Debra Henry was appointed to the support staff in July 1996. Departures from the Center's staff over the past year include research staff members Virginia Esau, Administrative Officer for the past nine years who transferred to the Physics Department as Administrative Officer in May 1997; and Richard Perilli, who resigned in July 1996.

Of the seventeen students participating in the CMSE Undergraduate Research Opportunities Program, funded by the National Science Foundation as part of the MRSEC Program, six were women and eleven were men. For the fourth summer, CMSE is collaborating with the MPC in sponsoring a joint ten-week summer internship program. Eight interns were selected from applications submitted by over 100 undergraduates from both MIT and other universities from around the country. Two of these scholars are women and one is an African-American. The interns include Bababunmi Adekore (North Carolina State University), Ian Appelbaum (Rensselaer Polytechnic Institute), Jennifer Craft (Mississippi State University), Jenny Cutler (Brigham Young University), Jeffrey Gore (MIT), Christopher

Leitz (Pennsylvania State University), Andrew Read (University of Illinois), and Miroslav Shverdinovsky (Cornell University).

As part of its outreach program, CMSE participates in the cooperative employment in its shared experimental facilities of students from Northeastern University and Wentworth Institute. Three students were employed this year. One is a woman and two are men. One of the students is African-American. Suzanne Nicol, Nikolay Pokrovskiy, and Patrick Boisvert have worked as co-op students in two of the Center's SEFs over the course of the past year.

The Center continued its very successful science and engineering summer day camp for seventh- and eighth-grade students from a local public school who are members of underrepresented minority groups. This year's students included six African-Americans and four Hispanic-Americans, of which seven were male and three were female. The students were supervised by volunteer faculty and staff, as well as four MIT undergraduates, including one of Hispanic ethnic origin. These students were Julieann Villa, Melody Kuroda, Farzana Mohamed, and Elaine Haberer.

We continued the CMSE graduate minority research assistant (RA) program to fill the need for support for minority students in their last two years of graduate study. During the 1996-97 academic year, the Center provided RA support to an African-American woman in the Department of Physics and an Hispanic male in the Department of Chemistry. In addition, seed funding was granted to one female faculty member working in the field of materials science and engineering who is a member of an under-represented minority group.

More information about the Center for Materials Science and Engineering can be found on the World Wide Web at the following URL: <http://web.mit.edu/cmse/www/>.

Marc A. Kastner

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. The CEEPR is directed by Professor Richard Schmalensee, with Dr. A. Denny Ellerman, Executive Director, and Joan E. Bubluski, Administrative Assistant.

For more than 20 years, the Energy Laboratory has sustained a unique organizational structure to develop and implement strong single- and multi-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 FY97 involved about 50 undergraduates and 130 graduate students, along with about 55 associated faculty members from twelve Academic Departments representing all five of MIT's Schools.

HIGHLIGHTS

- A new graduate elective, *Sustainable Energy* (22.811J/10.391J/TPP66), was offered in the Spring term. The course was taught collaboratively by members of the Energy Laboratory and the Nuclear Engineering Department, with participation of other experts from within and without MIT. In addition to about ten listeners, twenty-six students completed the course which included topical papers and oral reports. The level of student participation, the richness of international viewpoints, and the interactive learning, have provided a springboard for future improvements in an exciting course on an important global topic.
- The Energy Laboratory research volume for FY97 was \$14.4 million. The University Research Consortium (URC - on behalf of the Lockheed Martin Idaho Technologies Company) accounted for \$7.6 million of the volume, with 47 research projects being supported at 23 different universities. URC management and the 17 URC research projects at MIT amounted to \$3.9 million.
- We are continuing being a world leader in our work relating to technologies for carbon dioxide mitigation through capture and sequestration of fossil-fueled power plant emissions. The *Third International Conference on Carbon Dioxide Removal*, was held at MIT in September 1996, and attracted about 250 delegates from 26 countries. Prior conferences were held in Amsterdam in 1992 and in Kyoto in 1994. Howard Herzog chaired the organizing committee for the conference and edited the *Proceedings* which have now been published by Pergamon Press.
- In January, we published at the request of the US DOE a follow-up White Paper entitled "CO₂ Capture, Reuse, and Storage Technologies for Mitigating Global Climate Change."
- To aid the Chinese government in evaluating several options for using coal as a source of energy for automotive fuels, MIT collaborated in a life cycle analysis study with the Ford Motor Company, Tsinghua University, and several agencies of the government of the Peoples Republic of China. The MIT portion of the work was led by Dr. Malcolm Weiss. Results have been discussed informally with three government agencies in China and the official report will be presented to the government in July 1997.
- A report entitled *Energy Technology Availability: Review of Longer Term Scenarios for Development and Deployment of Climate-Friendly Technologies* was prepared for the International Energy Agency (Paris) under sponsorship of the New Energy and Industrial Technology Development Organization (NEDO) in Tokyo. Mr. Herzog and Dr. Drake were principal authors.

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 and managed by Dr. Victor Wong, continues promising research to improve fuel economy and utilization within the engine and reduce adverse emissions. The Consortium on Engine Research has been combined with the Engine/Fuels Interactions Consortium to highlight the common interests of sponsors from both the automotive and petroleum industries. Many of the sponsors in the resulting Engine and Fuels Consortium also participate in the Consortium on Lubrication in Internal Combustion Engines. The Sloan Laboratory also engages actively in basic combustion

research in advanced engine systems with US DOE support, and in engine emission research with support from the EPA Research Center on Airborne Organics.

Energy Laboratory collaboration with the *Center for Environmental Health Sciences* (CEHS - directed by Professor William Thilly) seeks to determine how combustion emissions and effluents from treatment of hazardous wastes may lead to adverse human health impacts. The Energy Laboratory is an active member of the *Program for Environmental Engineering Education and Research* (PEEER) under the leadership of Professor David Marks and has also worked over the years with the *Building Technology* program (led by Professor Leon Glicksman) in research on energy efficient, "healthy" buildings.

With the formal retirement of Professor Adel Sarofim from MIT, Professor Jack Howard has become the director of the *EPA Center on Airborne Organics*. This Center, focusing on sources, atmospheric transport and transformation, monitoring, and control of airborne organic compounds, is staffed with colleagues from MIT, the California Institute of Technology, and the New Jersey Institute of Technology. MIT scientists participating in Center research projects include Professors János Beér, Heywood, Simone Hochgreb, Howard, Gregory McRae, Sarofim, and John Vander Sande. In addition to the research, the Center hosts an annual Summer Symposium on high visibility topics in ambient air quality. In 1996, the meeting addressed *Advanced Instrumentation for Air Quality Measurements* and was chaired by Professor Richard Flagan of CalTech and Dr. Charles Kolb, President of Aerodyne Research Inc.

Continuing our prior internationally visible work relating to technologies for carbon dioxide mitigation through capture and sequestration of fossil-fueled power plant emissions, we completed a study for the US DOE to investigate the potential environmental impacts of ocean disposal of carbon dioxide. The final report is co-authored by Mr. Herzog and Dr. Eric Adams of the Parsons Laboratory.

The MIT Energy Laboratory has continued its administration of the *University Research Consortium* (URC) on behalf of the Lockheed Martin Idaho Technologies Company (LMITCO), the operations and management contractor for the DOE Idaho National Engineering and Environmental Laboratory (INEEL). During the past fiscal year, the URC has supported 47 research projects at 23 universities in 17 states at a total funding level of over \$7 million, including 17 projects at MIT. These projects, done in collaboration with members of the INEEL staff and private sector participants, are designed to help INEEL in its reorientation to the new goals set by DOE for its national laboratories.

No new projects were begun during FY97, but a solicitation of new proposals was published for projects to start during FY98 in research areas including treatment of mixed (nuclear) wastes, management of water resources, nuclear technologies, natural disaster-resistant structural design and testing, and agricultural technologies. MIT provides oversight of the continuing projects and participates in the technical evaluation of proposals for new projects. As part of the oversight role, MIT conducts a summer review meeting in Idaho Falls, at which each principal investigator discusses research progress before an evaluation panel in an open meeting. Professors Tester and Mujid Kazimi are the co-Principal Investigators for the URC, which is directed by Dr. Weiss. Other URC leadership is provided by Dr. Drake, the program co-director, and by Technical Focus Area Leaders who are: Professors Merton Flemings (Advanced Engineering Systems), Kent Hansen (Nuclear Technologies), and Kenneth Smith (Environmental Engineering).

Professor Hansen and Dr. Weiss completed research sponsored by the DOE related to management of nuclear waste from the DOE weapons program, with recent emphasis on the Hanford waste tank system. The waste stored in the tanks represents one of the most significant public risks in the entire weapons complex. Management of the operations of the system is very complex technically and administratively. The research focused upon developing a system dynamics model of the waste tank management and operations to permit simulation of performance for a variety of policy options.

The *Electric Utility Program* (EUP), directed by Mr. Stephen Connors, is jointly sponsored by twenty-five electric utility companies, equipment manufacturers, and fuel suppliers, and the DOE. EUP facilitates the development of collaboratively funded electric industry-related research projects by bringing together MIT faculty and researchers with EUP members through an annual series of workshops and meetings. Meetings at MIT over the past year included the annual planning meeting which focused on the role of changing prospects for knowledge-based

(academic) research in the evolving competitive and global electric industry, and three workshops. Two of these workshops served as kickoff meetings for two separate consortium projects. The first is a project exploring possible biophysical mechanisms related to electromagnetic field (EMF) exposure, led by Dr. James Weaver. The second project, entitled *Transmission Provision and Pricing Under Open Access* is led by Dr. Marija Ilic.

The EUP is currently in the process of changing its organizational structure to better attune itself with the changing structure of the industry. This will entail breaking up the EUP into more functional tracks associated with generation, transmission and distribution, energy and environmental services, and overall industry coordination and environmental performance. We anticipate that such a reorganization will provide better communication and collaboration between industry and individual MIT researchers and research groups. The EUP will continue to serve as a source of information to MIT faculty and staff, including the Industrial Liaison Program, regarding electric industry trends and leaders.

The *Analysis Group for Regional Electricity Alternatives* (AGREA), also directed by Mr. Connors, employs multi-attribute power systems planning tools to identify environmentally-responsible and cost-effective electric development strategies. Under the auspices of the Alliance for Global Sustainability, AGREA is applying its experience in strategic planning via the SESAMS project (Strategic Electric Sector Assessment Methodology under Sustainability Conditions) in Switzerland, in collaboration with the Swiss Federal Institutes of Technology (Zurich and Lausanne) and the Paul Scherrer Institut. AGREA is also currently assisting in the evaluation of water and energy strategies for the Argentine province of Mendoza, in a project led by the Technology and Development Program. AGREA continues to be active in the assessment of environmentally proactive emissions reductions strategies for New England. Through his EUP and AGREA research activities Mr. Connors is active in both the World Energy Council as a member of the Technical Program Committee for its 1998 World Energy Congress in Houston, and as a representative of the academic community in the Massachusetts Renewable Energy Collaborative.

A major collaborative program between MIT and the INEEL, with funding from DOE Basic Energy Sciences, seeks new engineering understanding to improve efficiency and materials conservation in energy-intensive processes. This program, with one project led by Professor David Parks and another by Professor Thomas Eagar, is directed by Dr. Drake.

The Energy Laboratory is in the last year of a five-year grant proposal from the DOE Office of Energy Efficiency and Renewable Energy for *Research and Assessment Studies in Support of DOE Programs* including analytical capabilities development for research and development and technology transfer related to improved resource conservation and environmental quality. This grant, managed by Dr. Drake, has resulted in a series of about ten successful research projects. The final projects include two led by Dr. Marija Ilic, the first characterizing the needs of a restructured electric transmission and distribution system, and a second, focusing on effective energy management under competition with real-time controls, accounting, and supporting systems. The third project, directed by Professors David Marks, Fred Moavenzadeh, and John Sterman has developed systems dynamics-based planning tools for municipal solid waste managers and industries.

Under the University Research Initiative of the Department of Defense, a five-year fundamental and applied research program on the use of chemical reactors for supercritical water oxidation of military toxic wastes is being conducted for the Army Research Office (ARO). Goals are to develop new understanding of important chemical and physical processes for successfully applying this technology, e.g., how rapidly and completely wastes can be destroyed, how fouling of vessel surfaces by solids can be minimized, how solid byproducts can be separated, and how corrosion of processing construction materials can be controlled. A related goal is to use this understanding to develop reactor models and process flowsheet simulations that will aid in the eventual implementation of the technology. The project team is led by Professor Tester and involves Professors Tomas Arias, David Cory, Peter Griffith, Howard, Ronald Latanision, and Kenneth Smith, Dr. Michael Modell, Dr. Peters, and Mr. Herzog, as well as visiting faculty from Merrimac College, Professors Angelike Regos and Katherine Swallow.

CEEPR AND JOINT PROGRAM

The 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 a number of corporate sponsors in

North America, Europe, and Japan; the U.S. and Norwegian governments; and the Vetlesen 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 *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 Henry Jacoby and Ronald 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 Joint Program is now in its fifth year of existence during which time it has become established as one of the world's leading centers for the Integrated Assessment of Climate Change. The Integrated Global Systems Model is now operational and has provided 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 continue to grow with annual funding now exceeding \$3 million.

CEEPR research outside of the Joint Program has focused on three areas: emissions trading, productivity improvements in the supply of energy, and energy futures, forwards, and arbitrage. By merit of its research on the Title IV SO₂ 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. The work on productivity is concerned with determining the sources and causes of the remarkable improvements that have occurred over the past 10-15 years in the supply of conventional hydrocarbon energy supplies. Most of the current work has been concerned with coal; however, with the cooperation of the Norwegian government, this research is being extended to cover oil and gas, using the North Sea as a case study. 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 as well as to the current development of such markets for coal and electricity.

NEW INITIATIVES

The Energy Laboratory is launching a new initiative, Energy Choices for the 21st Century, to bring improved and factual energy technology forecasting and assessment to initiatives seeking practical options for cleaner and more environmentally-friendly energy supply and use in the future. This initiative is the outgrowth of collaboration with the Joint Program to improve the adequacy of the technology component in the Integrated Global Systems Model and from concerns about the role of present and future energy choices on the local, regional, and global environment, under the leadership of the Program in Environmental Engineering Education and Research (PEEER), the *Alliance for Global Sustainability (AGS)*, a collaboration between MIT, Eidgenössische Technische Hochschule (ETH - Switzerland), and the University of Tokyo. The *Energy Choices Program* will interface with the Joint Program and other AGS activities and is seeking funding from the AGS, corporations, government agencies and a foundation. A major initial planning meeting is scheduled for November 1997, bringing together a diverse and international group of energy and policy experts, to plan the specific goals and research agenda for the program.

In July 1997, Mr. Herzog will play a major role in a DOE workshop on Fuels Decarbonization and Carbon Sequestration. There are obvious synergies between mitigation technologies and the Joint Program on the Science and Policy of Global Change (described further under the CEEPR), which will be highlighted in conjunction with this meeting. Mr. Herzog and Dr. Adams are in the final phase of negotiations for leading an international experiment in ocean disposal of CO₂. This project will be a collaboration between the US, Japan, and Norway under the Climate Technology Initiative of the Framework Convention on Climate Change.

The Energy Laboratory is coordinating a national program aimed at developing new technologies for rapid drilling, tunneling, and cavity creation in rock formations. Important applications include drilling for exploitation of deep petroleum, gas, and geothermal energy; mining; and tunneling for infrastructure expansion and revitalization. Under the leadership of Professor Carl Peterson, a National Advanced Drilling and Excavation Technologies (NADET) Institute has been established at MIT with initial funding from the DOE. MIT contributions include expertise in engineering (Professors Kim Vandiver, Herbert Einstein, Peterson, and Tester) and earth sciences (Professor Nafi Toksoz and Dr. Roger Turpening). The major function of the Institute is to be carrying out industry-guided and co-funded RD&D on proposed new technologies. The first proposal solicitation and evaluation has taken place under

sponsorship of the Geothermal Division of the DOE and five research contracts were awarded. We expect to continue our project management, research, and technology transfer roles as the NADET continues on a national scale with U.S. universities as well as government and industrial laboratories encouraged to participate.

Since the University Research Initiative funding for supercritical water oxidation research will cease in early 1998, follow-on support is being sought through a proposed industrial consortium (The Supertech Consortium) and through several other research proposals to DOD, DOE, NSF and EPA. These research initiatives will focus on chemical synthesis in supercritical fluids, on salt formation and deposition in supercritical water, on the use of power ultrasound to initiate supercritical water reactions for cleaning contaminated soils *in situ*, and on instrumentation for characterizing the growth of salt particles. One of these proposals, for computer simulation of supercritical water reactions and reactor flowsheets, has recently been approved for funding under an ARO-STTR.

More information about the Energy Laboratory can be found on the World Wide Web at the following URL:
<http://web.mit.edu/energylab/www/energylb.htm>.

Jefferson W. Tester

FRANCIS BITTER MAGNET LABORATORY

During the past year, the Francis Bitter Magnet Laboratory (FBML) has made notable advances in several areas of science and engineering involving high magnetic fields. The research program in Magnetic Resonance (primarily nuclear magnetic resonance (NMR), but also including electron paramagnetic resonance (EPR)) has continued to grow and is now the largest effort at the FBML. The program continues to be funded primarily by the NIH and DOE, and involves ~20 NMR and EPR magnets and spectrometers some of which have been custom designed, some acquired commercially. These include a wide bore 360 MHz, two wide bore 500 MHz, three 600 MHz, and two 750 MHz NMR systems. In addition, we now operate the sole 140 GHz EPR spectrometer in North America, and have recently acquired a new widebore magnet with an expanded range sweep coil for this system.

A web site describing some of our research can be found at the following URL: nuts.mit.edu.

RESEARCH HIGHLIGHTS MAJOR ACCOMPLISHMENTS

We used our newly developed technique of high resolution NMR scattering to make the first direct measurement of rate of spin diffusion through a homogeneous dipolarly coupled solid (single crystal calcium fluoride). This measurement has been the focus of theoretical studies for the past 30 years and a variety of failed experimental studies. In many respects it is an ideal test system for multi-body theories and our experimental results should help reinvigorate this area.

We used our new approach to high resolution NMR of semi-solids (based on a combination of magic angle sample spinning and magnetic field gradients) to quantify the correlation of molecular diffusion, compartmentalization and variations in the local magnetic susceptibility. These methods will find use in characterizing the average local structure of biomedical systems at sub-micron length scales.

We have extended the recently developed paradigm of "NMR computation" to demonstrate that quantum computing is accessible through the complexities of an ensemble and that fundamental quantum behavior is still observable following the ensemble average.

RESEARCH ACTIVITIES

High Resolution NMR Microscopy - We have continued to push for higher resolution and sensitivity NMR microscopic images, particularly through the implementation of diffusion insensitive slice selection methods, rapid constant time imaging schemes based on reduced k-space sampling and the characterization of micron structures via local gradients.

RF Gradient Spectroscopy - We continue to explore the applications of novel radio frequency gradient hardware and methods to improving structural and dynamic studies of bio-molecules by NMR. Recently we have explored the applications of RF gradients to bi-linear rotation sequences (BIRD and TANGO) and have developed a more robust two channel NMR probe.

High Resolution NMR Scattering - We have completed the spin diffusion measurements discussed above, and an improved version of the high gradient strength probe. We are now turning our attention to measures of mesoscopic spin dynamics.

MRI of Soil Remediation - (with Prof. P. Culligan-Hensley, Civil and Env. E). We have completed a set of measurements that show the images of oil displacement by a water stream in a packed bead system. This provides the only direct, non-invasive, three-dimensional data on the efficiency of oil removal and is needed as a link to microscopic models of the system.

Applications of NMR to Liposarcoma Grading - (with Dr. S. Singer, BWI and Dana Farber) We have seen that gradient, HR-MAS is indeed a powerful means of exploring the chemistry and compartmentalization of sarcomas and have expanded the study to include cultured cell lines.

DNP AND EPR

Dynamic nuclear polarization (DNP) provides a mechanism for transferring the high spin polarization of unpaired electrons to relatively less-polarized nuclear spins. Sensitivity enhancements of up to 3 orders-of-magnitude are possible with this technique. We have recently achieved reproducible enhancements of 50 for CP/MAS (cross-polarization/magic angle spinning) spectra of the 18.7kD protein T4 lysozyme in frozen solution with the spin label TEMPO as the source of unpaired electrons. Polarization is first transferred from electron to proton spins under microwave irradiation; proton spin diffusion and subsequent CP to low-gamma spins (e.g., ^{13}C , ^{15}N) allows uniform polarization across the sample. The electron-nuclear polarization transfer is primarily driven by the thermal mixing effect, where off-resonance irradiation of the TEMPO EPR (electron paramagnetic resonance) line perturbs the electron dipolar bath, and electron-electron-nuclear spin flips drive polarization transfer to the nuclei. The efficiency of this process depends critically on the homogeneous nature of the EPR lineshape. Spectral spin diffusion can render the typically inhomogeneous EPR line effectively homogeneous for the purposes of this effect. The timescale and spectral variation of the spin diffusion effect was studied via ELDOR (electron-electron double resonance) and electron spin-echo relaxation measurements. Experiments varying radical concentration, magnetic field strength, and temperature reveal additional features of the spin diffusion effect and the polarization transfer mechanism.

SOLID STATE NMR STUDIES OF PEPTIDES AND PROTEINS

We extended our understanding of the vector pictures of MAS (magic angle spinning) to cases involving an axially asymmetric tensor. We also developed an extended treatment of frequency selective heteronuclear recoupling sequences and MAS which is useful for distance measurements between ^{13}C and ^{15}N and ^{31}P and ^{13}C . We initiated experiments to obtain high resolution spectra of $I \geq 3/2$ nuclei via multiple quantum excitation. The initial results employed two pulse sequences, and we have recently improved the methodology via a 3Q to 1Q transfer scheme referred to as "RIACT" (Rotationally Induced Adiabatic Coherence Transfer). The RIACT approach should be especially useful for ^{17}O NMR in biological systems. We reported the initial MAS spectra of H_2^{17}O . Resolution is always a problem in NMR spectra and we explored the possibility of significantly increasing the resolution via 3D ^{15}N - ^{13}C - ^{13}C chemical shift correlation spectra. The spectra exhibit some unique features (very asymmetric 2D slices) and a theory was presented explaining these features. Efforts are also underway to determine peptide torsion angles via correlation of ^1H - ^{15}N and ^{13}C - ^1H dipolar tensors. The advantage of this approach over distance measurements lies in the fact that distances are often not sensitive functions of ϕ and ψ . Direct measurements of torsion angles circumvents this problem. We published findings describing rotational resonance tickling (R^2T), a new approach to measuring distance, which employs selective excitation and is capable of probing a long distance (weak dipole coupling) in the presence of a short distance (strong coupling).

We have made significant progress in developing methods that will be useful for determining the structure of large and/or insoluble proteins or peptides, we have improved the resolution with new 3D sequences. We have continued experiments on $I \geq 3/2$ nuclei via multiple quantum excitation, which could be widely applicable to biological systems. Finally, we have described two new approaches to structural studies: torsion angle measurements and selective distance measurement.

SOLID STATE NMR STUDIES OF MEMBRANE PROTEINS

We published findings describing the origin of the line broadening in membrane peptide and protein spectra. While the experiments involve a small molecule, the important point is that it exhibits motion on the time scale of the ^1H decoupling. In this case the decoupling interferes with the recoupling. We have developed a new approach to perform heteronuclear recoupling. We analyzed ^2H lineshapes for a flipping H_2O molecule which will be useful for describing membrane protein dynamics. We developed a new approach to dipolar recoupling in lipid bilayers used to measure segmental order parameters. We investigated the structure of the Schiff base counterion interaction with an emphasis on the 13-cis form and the L-intermediate via low temperature experiments. We continued our study of the effect of diffusion of peptides on spectra in lipid bilayers – in this case Gramicidin-A. We also published new approaches to measuring torsion angles via multiple quantum NMR effects and an approach to 3D spectroscopy of membrane proteins.

Our results demonstrate convincingly that we are able to measure distances in membrane peptides and proteins and establish the mechanism of the intensity losses in the spectra. The results establish the structure of the Schiff base in the L-intermediate of bacteriorhodopsin.

The condensed matter physics effort at the FBML is focused on spin-dependent tunneling between magnetic films of CrO_2 . The films have potential applications in the digital electronics industry, automobiles and medical diagnostics. Last year, we reported that the Stark-Faraday effect in GaAs-AlGaAs structures at $0.8\mu\text{m}$ had been observed. The effect has possible optoelectronic device applications and a patent was recently granted for devices based on the effect.

CRYOTRIBOLOGY AND "ELECTROMAGLEV"

This program's principal objectives have been to advance the theoretical understanding of low-temperature sliding behavior and to expand the cryogenic tribology data base. The program has been highly successful over the years and provided a database that is unique and very useful for the design of superconducting magnets and cryogenic devices. As research activities in the past few years have shifted, particularly in the US, from design and operational issues of low-temperature superconducting (LTS) magnets to those of high-temperature superconducting (HTS) magnets, mechanical disturbance---friction heating---that is of paramount importance for LTS magnets and has been the basis for our research activities, has become less pressing. Because of this shift in research emphasis from LTS to HTS magnets, while still continuing to generate additional cryotribology data, we have initiated a new HTS research program under this project: a new magnetic levitation system we call "electromaglev," in which an HTS bulk sample, e.g., YBCO, is levitated stably in a DC magnetic field generated by electromagnets placed underneath the floating object. During the past year a comprehensive study, both theoretical and experimental, has been completed and results will appear in *Cryogenics*.

PROTECTION FOR HTS MAGNETS

We completed, and published results of, an experimental and analytical study of two-dimensional normal zone propagation in pancake test coils, wound with silver-sheathed BSCCO-2223 tapes. Two test coils were studied in detail, one having 3 layers and the other 8 layers. Each test coil was housed in an adiabatic environment whose temperature (20-70 K) was controlled and maintained by a two-stage G-M cryocooler and placed in a background field (0-6 T) generated by a Bitter magnet. With a test coil carrying a transport current (0-200 A), a local heat disturbance was applied by a heater attached to the coil's outermost layer. The coil's resulting electrical and thermal responses were recorded with voltage taps and thermometers attached to the coil. A normal zone propagation code was developed to simulate each coil's voltage and temperature responses for both quenching and recovering events. The code solves the nonlinear transient heat diffusion equation in two-dimensional cylindrical coordinates with a finite difference method. As an application of this code, a two-coil system, each coil comprised of one double pancake wound with silver-sheathed BSCCO tape, was studied for its quench behavior as one of the coils was driven normal locally. The simulation results indicated that the value of a shunt resistor connected across the terminals of each coil had a profound effect on the level of hot-spot temperature reached in the quench initiation spot. The research is continuing with layered HTS coils to study normal zone propagation in 3 directions. Intermagnetics General Corporation (IGC) and Sumitomo Electric Industries have generously donated the BSCCO-2223 magnets used in our experiment.

DEVELOPMENT OF "PERMANENT" HTS MAGNET SYSTEM

A US patent has recently been granted to one of the MTD members on the concept of a "permanent" HTS magnet system. The newly patented system combines the simplicity and ease of operation of a ferromagnetic permanent magnet with the strength capability and versatility of an electromagnet through the use of high-temperature superconductors and a new approach to the operation of superconducting magnets.

Once energized and producing a desired field, the system, without being coupled to a cryocooler for refrigeration, can maintain the field for a long period. This cryocoolerless lightweight, "permanent" HTS magnet is particularly suitable for on-board and/or portable applications, where "permanence" in most applications means a duration of hours, days, weeks, months, or perhaps years. Note also that unlike a conventional permanent magnet, this "permanent magnet" can also be used as an energy source. Two other innovative ideas incorporated into the newly patented system are "recooling" and "recharging" capabilities. That is, the system is designed to be re-cooled while it maintains its constant field so as to make, through periodic recooling cycles, the field literally permanent; it may also be recharged if its upper operating temperature is exceeded and the field decays.

Condensed matter physics research in the areas of thin film magnetism, semiconductors and superconductors is being conducted with benefit to fundamental knowledge as well as future application. For example, our recent success in spin dependent tunneling, anticipated for over 25 years, has not only opened fundamental questions but also is extremely promising for ultra high density recording ($>10\text{Gbits/in}^2$), non volatile memory elements, and sensors alike. Several major companies including IBM, Philips, Motorola are working on this new technology. For far future atomically resolved storage ($>1\text{Tbit/in}^2$), semiconducting phase change materials are being explored, with funding from a major company. Academically, in addition to graduate students, post docs, undergraduates, even high school students participate in the research program. National and international collaborators from universities, national labs and industries are also involved. The research has been cited in various magazines and newspapers as well as scientific journals.

The Bleomycins (BLMs) are anti-tumor antibiotics which are presently used clinically in the treatment of head and neck cancer and testicular cancer. There, cytotoxicity is thought to be related to their ability to bind to double-stranded (ds) DNA and cause ds-lesions which are difficult to repair. While the chemistry of the DNA-cleavage reactions have been elucidated in some detail the basis for molecular recognition of a dGpPy sequence is still unknown. We have embarked on a program using solution-state two-dimensional NMR methods to determine the structure bound to an oligomeric DNA containing a single recognition site. We have chosen to examine a cobalt hydroperoxide analog of BLM which is an analog of the ferric peroxide BLM thought to be the activated species *in-vivo*. This species is chemically stable in the dark, it cleaves BLM with the same sequence selectively as iron BLM, its ligands are exchange inert, and it is diamagnetic. We have carefully chosen two oligomeric DNAs for examination, each containing a single BLM binding site and cleavage site. We have recently determined the first sequence-selective K_{ds} for CoBLM which range between $5 \times 10^{-6}\text{M}$ and 10^{-7}M . The oligomers being examined are $d(\text{CCAGGCCTGG})_2$ (1) and $d(\text{CCAGTACTGG})_2$ (2). A titration of CoBLM with each of these oligomers reveals a 1:1 complex in slow exchange on the NMR timescale. We have recently published the structure of CoBLM A₂ green complexed to (1), above (*J. Am. Chem. Soc.* **118**, 1268-1280 (1996)). We have also recently solved the structure of CoBLM A₂ brown form. In this case, the axial ligand is H₂O. Thus far we have been unable to define the screw sense of this analog. We have also acquired the data to solve the structure of phleomycin, an analog of BLM in which one of the thiazolium rings is reduced. Solutions of these structures should explain their sequence specificity in bonding to DNA.

We have been applying the spin-polarized tunneling technique to the study of unusual spin states in superconductors. These states include non-equilibrium conditions caused by the injection of spin-polarized carriers into a thin film superconductor and the Fulde-Ferrell state predicted to exist in special cases for superconductors at low temperature and high magnetic field. As part of this program, we have been investigating the tunneling properties of the conducting ferromagnet chromium dioxide for possible use as a source of spin-polarized electrons. Band structure calculations imply that this material might be a half-metallic ferromagnet and thus would be a superior electrode material for spin-polarized tunnel junctions. This work is supported by the NSF. Personnel include Paul Tedrow of the Magnet Laboratory staff and Professor Katsuhiko Suzuki of Miyagi National College of Technology, who is supported by the Ministry of Education of Japan.

We have published a preliminary model of the HIV TAR RNA in complex with argininamide. However, several features of this RNA are poorly resolved. The wild-type TAR RNA has a three nucleotide bulge (UCU) that is critical for formation of the correct structure such that the HIV tat protein can bind. A naturally occurring TAR variant has a two nucleotide (UU) bulge, and we have prepared this RNA for structural characterization. It binds to argininamide somewhat more tightly than the UCU bulge TAR, and we observe several new inter- and intramolecular NOEs in the bulge region. After collecting a huge number of 2D-, 3D-, and 4D- data sets on ¹³C-labeled RNA, and ¹⁵N-labeled RNA, we have obtained a large number of distance constraints. There are over 700 NOEs that define the structure of this 30 nucleotide RNA, including 20 intermolecular NOEs to the argininamide ligand. We have completed the structure determination, and the paper describing the structure is in press. The first U nucleotide in the bulge region forms a base triple with an A-U base pair in the upper stem, and the arginine binds immediately below this U base, interacting with a G-residue in the major groove. The guanidinium group is stacked between two bases, forming an arginine sandwich.

FACILITIES

The Magnet Technology group completed the winding of the major part of the 45T hybrid magnet to be installed at the National High Magnetic Field Laboratory in Tallahassee. In addition, the past year has seen the acquisition of five new magnets for the magnetic resonance research effort. These include a 104 mm, 500 MHz magnet for solid state spectroscopy, a 52 mm, 600 MHz magnet and spectrometer for microscopy and a similar system for solution NMR, and a 62 mm, 750 MHz magnet for solution and solid state experiments. Finally, we have acquired a 125 mm 5T magnet with a sweep coil for extended high field EPR experiments.

A new, one-of-a-kind Molecular Beam Epitaxy (MBE) system was built to explore the frontiers of spin tunneling, surfaces and interfaces of magnetic and semiconducting materials on an atomic level. This system will enable us to improve our fundamental understanding as well as future digital storage and sensor view point.

Plans are underway to consolidate FBML resources into one building as facilities currently housed in building NW17 (including two 750 MHz NMR magnets, a 200 MHz/40 cm NMR magnet, a wet lab and electronics shop) will be moved to building NW14. This consolidation will do much to enhance the FBML research center and to make space available for the LIGO project to move into when building 20 is replaced.

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 35 full time graduate and 14 postdoctoral students who are performing research.

Dr. Susan S. Pochapsky was hired as a Sponsored Research Staff member to improve the resources of the magnetic resonance facility.

FUTURE PLANS

Plans are continuing for a major expansion of MRI activities involving the Harvard/MIT Division of Health Sciences and Technology (HST). HST is in the process of recruiting senior faculty members in the area of functional MRI, and the FBML Director is working closely with HST faculty toward the recruitment of renowned individuals in this field.

A proposal to the NIH for the development of very high field, wide bore NMR magnets is awaiting a decision. If funded, the Technology Group would pursue the program for three years.

Preparation of the competitive renewal to fund the Center for Magnetic Resonance is underway and will be submitted to the NIH before the end of 1997.

Robert G. Griffin

HAYSTACK OBSERVATORY

Haystack Observatory, located in Westford, MA, is an interdisciplinary research center engaged in radio astronomy, geodesy, atmospheric sciences, and radar applications. The radio astronomy program is conducted under the auspices of the Northeast Radio Observatory Corporation (NEROC), a consortium of 12 educational and research institutions in the northeast. Wellesley College joined NEROC in the past year. The Observatory receives financial support primarily from federal agencies including the NSF, NASA, and the USAF through MIT Lincoln Laboratory.

INSTRUMENTATION

The Haystack Observatory instrumentation consists of the following facilities:

- A 37m-diameter radio telescope used for astronomical observations at wavelengths from 2.6 mm to 13 mm, as well as for wideband radar measurements at 3 cm.
- An 18m-diameter radio telescope involved in geodetic measurements of the earth's plate motions and orientation parameters using very long baseline interferometry (VLBI) techniques.
- A VLBI correlator used to process global geodetic experiments and astronomical observations at millimeter-wavelengths.
- A high-power 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 airglow emission and determine upper atmospheric winds.

RADIO ASTRONOMY

Highlights of the radio astronomy program using the 37m-diameter radio telescope in the past year include the discovery of ethylene oxide, the fourth cyclic molecule detected in the interstellar medium. The detection of complex organic compounds is important in the study of chemistry in molecular clouds. Observations of comet Hale-Bopp led to the detection of hydrogen cyanide and methanol, and the measurements are being used to better constrain the chemical production rates in the comet. Monitoring of the water vapor megamaser in the galaxy NGC 4258, which is thought to arise in a circumnuclear torus orbiting a supermassive black hole in the nucleus of the galaxy, led to the detection in March 1997 of a spectacular flare in its radio emission. Some of the possibilities being studied to explain the occurrence of such a bright flare include an exceptionally hot spot in the jet behind the maser that supplies seed radiation, or chance alignment of separate maser clumps in the disk around the galaxy center. Finally, a survey for infall motions in a large number of starless dense clouds was completed and led to discovery of an asymmetry in the distribution of velocities, particularly for the youngest stars in the sample. Further investigation of this asymmetry is planned as part of addressing a fundamental problem in astrophysics, namely how stars form.

During the past observing season, a total of 45 observing projects were conducted at Haystack by 80 members of the astronomical community, including 12 graduate students. A majority of the observing projects were carried out in the 85-115 GHz and in the 35-49 GHz frequency bands where the telescope provides excellent angular resolution and sensitivity. A new technique has been developed during the past year to allow the acquisition of continuum data in a fast-scanning mode needed to search for radio counterparts to gamma-ray bursts. A drift-scan procedure was also developed to enable the measurement of flux densities of small-diameter radio sources and the mapping of extended sources. Progress has also been made in the replacement of the control computer for the telescope, which is a necessary step towards the goal of remote control of the telescope. Our initial goal is to provide a capability to monitor observations remotely. To that end, a modernization of the servo and data acquisition systems has been completed in the past year, with much of the analog hardware replaced with digital units that enable the interfacing of the hardware with computer control through the Internet.

The astronomy program at Haystack is planned in the next year to shift its orientation from that of a facility supporting a broad collection of research projects to science-driven, in-depth investigations, consistent with the Observatory's university-based charter. The research will focus on two key projects: (1) a survey of point radio sources to aid in foreground subtraction for cosmic microwave background experiments and a search for radio counterparts to gamma-ray bursters and X-ray transients, to be led by Professor Jacqueline Hewitt (MIT Physics Department) with the collaboration of the Haystack staff, and (2) an extensive survey for infall motions in star-forming dense cores to be led by Dr. Philip Myers (Harvard-Smithsonian Center for Astrophysics) with the

assistance of Haystack staff. On a smaller scale, the telescope will also participate in VLBI experiments at mm-wavelengths led by Alan Rogers (Haystack). The goal is to focus the resources of the Observatory on programs that are well suited to the capabilities of the telescope, and hence insure that the Observatory will play a unique and valuable role in contributing to the solution of important astrophysical problems driven by the interests of its MIT and active NEROC communities. The proposal is now pending at NSF.

VERY LONG BASELINE INTERFEROMETRY

VLBI applied to astronomical observations at 3mm-wavelength, the Coordinated Millimeter-VLBI Array (CMVA) has operated successfully during the past year under Haystack's leadership. In the latest experiment in April 1997, eleven radio telescopes, globally distributed in the US, Europe, and South America, successfully participated in the largest array configuration to date to study the central region of our galaxy and to map quasars at the center of external galaxies with an unprecedented angular resolution of less than 50 microarcseconds. Recent scientific highlights include the mapping of a ring structure of silicon monoxide masers in a thin spherical shell within 1.5 stellar radii around the late-type star VXSGr. The measurements allowed the surprising discovery of a large scale linear velocity gradient among the masers, the first such gradient to be observed in any silicon monoxide maser source. If this observation is interpreted as an indication of rigid rotation, an accurate measure of the rotation rate of the star is obtained. In other important mm-VLBI experiments, the evolving structure of bright active galactic nuclei was mapped, tracing the ejection and expansion speed of material in the jet ejected from the core of galaxies such as 3C 111,3C273 and 3C279. In the blazar, NRAO 530, which underwent a large radio flare during the past year, the observations led to modeling of the flare structure in terms of a core, two shocks and a large halo, and revealed a distinct asymmetry in the structure which was not evident in previous observations. All recent scientific results from the CMVA were reviewed at a special workshop convened at MIT in November 1996 and attended by 40 astronomers and graduate students. Future scientific thrusts in mm-VLBI are aimed at high-resolution studies of the polarization structure in galaxies to determine magnetic field patterns, and at extending the observations to 1- and 2 mm-wavelength which will further increase the angular resolution of the observations.

In geodetic VLBI, applied to the study of the earth's plate motions and its orientation parameters such as rotation and precession rates, the main emphasis has shifted towards studying the short-term variations in the orientation parameters. An internationally-coordinated initiative called CORE (Continuous Observations of the Rotation of the Earth), has been organized to address this objective under NASA's leadership and with the participation of the Haystack Observatory. Seven VLBI networks, each consisting of five radio telescopes around the world including MIT's Westford 18m-telescope, will operate serially to observe changes in the earth's rotation rate and will identify changes on time scales of one hour. This research program was enabled by the development at Haystack of the next generation VLBI correlator, the Mark IV system, which will provide high processing throughput and enhanced sensitivity through increased recording bandwidth. Pilot observations have started in 1997 and the observing program will be at full capacity in 1999 when the Mark IV correlator becomes operational.

INSTRUMENTATION DEVELOPMENT

The Mark IV correlator subsystems designed at Haystack have been successfully tested during the past year and have met all specifications. Production of a large number of these subsystems is now in progress using local area industries, and the assembly of several correlators will be carried out over the next year. In addition to the Haystack correlator, copies will be constructed for the US Naval Observatory, the Smithsonian Institution, the Joint Institute for VLBI in Europe, the Netherlands Westerbork Array, and the Max Planck Institute in Bonn, Germany. Completion of the correlators to be used for VLBI data processing has been delayed due to difficulties in the station units that prepare the recorded data from the telescopes prior to their correlation. These units have been designed by an industrial firm in England and have not successfully passed the acceptance tests. The difficulties should be resolved by the end of the year. Haystack resources are being applied to assist with the solution of the problems.

An important element of the Mark IV system is the data acquisition electronics and recorders operating at the telescopes. The data acquisition technology, developed at Haystack, has now been transferred successfully to industry where various components have been reproduced for installation at various telescopes around the world. Our collaboration with Seagate Tape Technology Division continues towards the adaptation of thin-film recording head-array technology to high data rate recording of VLBI data. These head-arrays will enable magnetic tape recording at rates in excess of 2 Gb/s and will lower the cost of recorder head replacements compared to the present ferrite headstacks. A digital read-channel subsystem is also being developed at Haystack to increase the linear track

density. Such enhancements in recording rates and capacity are important for both geodetic and astronomical VLBI since they lead to enhanced interferometer sensitivity through the increase of the recorded signal bandwidth. Other advanced initiatives in recording technology are being developed with industrial groups at Kodak, Quantum and Hewlett-Packard Laboratories.

The ability of the VLBI technique to determine precisely the time delay in the arrival of a radio signal from a quasar has resulted in a spin-off that has societal benefits, namely a system that can provide the accurate location of a cellular phone issuing a 911 emergency call. In collaboration with and under the sponsorship of the Associated Group, Inc., a system based on precise range determination using the time delay of signals received at various cellular sites has been designed and tested in various locations. At present an operational prototype system is being exercised on the New Jersey Turnpike and has been shown to locate cellular phones to an accuracy better than 200m. Improvements in the digital signal processing system and the applicability of the technique to digital cellular phones are presently being explored.

The installation of a new surface on the Haystack antenna has been pursued in collaboration with Lincoln Laboratory. The new surface will triple the aperture efficiency of the radio telescope at frequencies of 85-115 GHz and open an observing window at frequencies of 150-160 GHz. The primary goal is to use the new antenna as part of a radar system at 95 GHz in order to enhance the resolution with which small satellites can be imaged and to increase the radar sensitivity so that asteroids can be tracked and imaged. The surface will consist of lightweight panels that are aligned using actuators. A laser interferometer measurement system will be used to determine the distortions from a parabolic surface that need to be corrected using the actuator system. Tests of this laser system are in progress at Lincoln Laboratory using a Haystack antenna panel in order to ascertain the accuracy of the measurements under various conditions. It is expected that detailed design studies for the new antenna surface and for the radar will begin in the next year. With this new surface, the Haystack radio telescope will become more competitive at short wavelengths.

ATMOSPHERIC SCIENCE

In the past year, the Millstone Hill ionospheric radar and the Observatory's optical instrumentation have gathered data during two major geomagnetic events triggered by coronal mass ejections on the Sun. In response to alerts received from satellites observing the Sun and measuring the energetic particles in the solar wind, the radar and optical instruments recorded the effects of geomagnetic substorms and storms as the energetic particles penetrated the earth's magnetosphere. These data sets have revealed large perturbations in the ionospheric plasma density and temperature, as well as enhancement in the plasma drift and neutral winds as the perturbations travelled from the magnetic pole towards the equator, passing over Massachusetts. The optical instruments imaged enhancements in the nightglow and auroral particle precipitation. Such observations are expected to receive increased emphasis as the solar cycle continues to increase towards a maximum in 2001. The measurements will be important to the study of the geomagnetic effects on satellite communications, satellite orbital changes, and ground induced currents, as part of our National Space Weather Program.

Two major initiatives have been the focus of our atmospheric science program in the past year. The first is the development of a lidar system as part of the atmospheric instruments clustered around the Millstone Hill incoherent scatter radar to allow the study of the coupling between the Earth's middle atmosphere(30-100 km altitude) and the upper atmosphere. The lidar would utilize the Lincoln Laboratory Firepond 1.2m-aperture telescope together with a 25 Watt Nd:Yag laser obtained through a collaborative effort with Clemson University. The combination of these two systems provides a lidar with the highest power-aperture product of any atmospheric lidar in the US. A Rayleigh-scattering capability was successfully demonstrated at Firepond during the past year leading to atmospheric density profiles up to 90 km. Design of a Doppler capability to be used with the fully-steerable Firepond telescope has been completed, and this would provide measurements of the vector winds in the middle atmosphere. Grant requests have been made to the NSF Major Research Instrumentation program and the CEDAR (Coupling, Energetics, Dynamics of Atmosphere Regions) program in order to implement the Doppler capability and to operate the lidar system to study the effects of tidal and gravity wave propagation from the Earth's lower atmosphere into the upper atmosphere

The second initiative in atmospheric science is the participation of the Haystack Observatory in the design and development of the Polar Cap Observatory (PCO) at Resolute Bay, North West Territories, Canada, in response to

an NSF solicitation. The PCO is one of the major NSF initiatives under the Major Research Equipment program for FY98. MIT/Haystack, SRI, Boston University and the University of Michigan pre planning the submission of a joint proposal to NSF for this important development. MIT/Haystack's responsibility will be the design and development of the data acquisition system for the incoherent scatter radar that is the central element of the PCO. This system will remotely control the radar, monitor its data output and analyze its observations in real time. The radar is planned to be a phased array system capable of rapid electronic steering (responsibility of the PI institution, SRI). A suite of optical instruments will also be placed at the PCO consisting of imagers and photometers (Boston University) and Fabry-Perot Interferometers and lidars (University of Michigan). The overall PCO development is expected to take three years, and will become operational in 2001, near the peak of the solar cycle when important geomagnetic effects will occur. The study of such effects at the Earth's polar cap is crucial to understanding the phenomena that couple the Earth's ionosphere and magnetosphere to solar perturbations that drive the dynamics of the Earth's upper atmosphere at all latitudes. The PCO will form an important element in the chain of observatories from the equator to the pole, including MIT's Millstone Hill radar at midlatitude, which are dedicated to the study of the structure and dynamics of the Earth's upper atmosphere.

EDUCATIONAL PROGRAMS

Haystack Observatory programs and facilities present an excellent opportunity to link education and research by undergraduates. Accordingly, a new initiative was undertaken at Haystack during the past year to encourage undergraduate students to practice radioastronomical observations as part of their study curriculum. In pilot projects at MIT (IAP), Harvard University, Boston University and Connecticut College, 40 undergraduates utilized the Haystack telescope to design experiments, gather data and analyze the observations. A grant request has been submitted to the NSF Education and Human Resources and the Division of Astronomical Sciences to formalize this initiative and provide access to the telescope for undergraduates in the region. MIT and the University of Massachusetts at Lowell will be initial test sites for new projects and software development that will enable students to control the telescope remotely to gather data, once hands-on training has been completed. In addition to the use of the 37m-telescope, a small radio telescope, 3m in diameter, will be made available for construction and use by undergraduates, based on a prototype that has been developed at Haystack. The project has been approved for funding by NSF for the next two years, and the development of projects at Haystack has begun. After the initial testing phase, we expect to expand the research projects to undergraduates in colleges and universities in the northeast, in preparation for national access.

Our graduate educational programs have also continued successfully during the past year. Twelve graduate students have used the telescope for observations used in thesis research. The Haystack undergraduate summer internship program involves 12 students this year, recruited from across the nation. The students are mentored by members of the Haystack staff and participate in the staff's research projects in astronomy, atmospheric science and instrumentation development. The pre-college outreach effort, called the Haystack Young Scholars program, has also continued this year and involves 56 students and three science teachers from 20 towns around Haystack. Following a three-week summer program, each student carries out an individual project during the academic year under special mentorship by our staff. This effort represents our educational contribution to our neighboring communities.

More information about the Haystack Observatory can be found on the World Wide Web at the following URL:
<http://www.haystack.edu/haystack>.

Joseph E. Salah

NUCLEAR REACTOR LABORATORY

During the past year the Nuclear Reactor Laboratory (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, radio-chemistry and trace analysis applied to the health effects from energy use, nutrition, earth and planetary sciences, archeology, environmental studies, and nuclear medicine. Plans are in progress for an upgrade of MITR to 10 MW. Engineering studies have indicated that the current core design will allow doubling of the reactor's power with relatively minor changes to the heat removal systems.

An especially noteworthy development was the continued program in joint research with Beth Israel-Deaconess Medical Center on the treatment of cancer utilizing the boron neutron capture method. The clinical trials of boron neutron capture therapy were continued successfully with no observed toxicity and with clear indications of tumor regression in several cases. Patient trials are now in progress for both melanoma and glioblastoma multiforme (brain cancer).

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. A new initiative in neutron beam tube research has been initiated and, as a first step, a neutron reflectometry system has been designed by a faculty team headed by Professor X.-L. Zhou (Department of Nuclear Engineering).

ENVIRONMENTAL RESEARCH AND RADIOCHEMISTRY

Professor Frederick A. Frey, Department of Earth, Atmospheric and Planetary Sciences, and Dr. Pillalamarri Ila operate a Neutron Activation Analysis Facility dedicated to determining the abundance of trace elements in natural materials. The current emphasis is on determining the chemical composition of lavas erupted from upwelling mantle plumes which are postulated to be an important part of the mantle convection cycle. Current research is focused on lavas erupted during the 115 million year history of the Kerguelen mantle plume which has contributed to forming the oceanic crust of the eastern Indian Ocean. The JOIDES Resolution, the research ship used in the Ocean Drilling Program will be used to acquire the oldest, perhaps 115 million years, lavas associated with this mantle plume. This research complements our efforts in the ongoing Hawaiian Scientific Drilling Program which is focused on the Hawaiian plume. This program is entering Phase 2 of a drilling project which will recover lavas erupted during the 1 million year growth of a Hawaiian volcano.

Dr. Ilhan Olmez continued a major attempt to increase the utilization of NRL by making its neutron activation analysis facilities and expertise available to industry, other universities, private and governmental laboratories, and hospitals. Research and/or service-oriented collaborations were established with several MIT research laboratories as well as with other educational and research institutions including: University of Miami, University of Southern California, Harvard, Woods Hole Oceanographic Institute, Brandeis University, and the California Institute of Technology. Commercial organizations that utilized the NAA expertise of the NRL during the past year were Physical Sciences Inc., Andover, Massachusetts; the Empire State Electric Energy Research Corporation (ESEERCO), New York; the Electric Power Research Institute (EPRI), Palo Alto, California; CARNOT, Tustin, California; Florida Power and Light, Florida, Energy Research Corporation, Danbury, Connecticut, and Spire Corporation, Bedford, Massachusetts.

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), Professor Harold F. Hemond (Department of Civil and Environmental Engineering), and Professor Adel I. Sarofim (Department of Chemical Engineering).

Dr. Olmez has been actively engaged in a number of environmental research projects. A two year grant to study toxic substances from coal combustion and a three year grant to determine the sources and the effects of fine particles on visibility in the Eastern United States supported through Department of Energy and Electric Power Research Institute continued.

Course, 22.78 Nuclear Techniques in Environmental Analysis, was offered by Dr. I. Olmez. There are currently two Ph.D. candidates (Nuclear Engineering Department and Chemical Engineering) and a Master's student from Center for Environmental Health Sciences working on projects in environmental research.

A number of other research applications of NAA are summarized in a subsequent section, Reactor Irradiations and Services for Research Groups outside MIT.

NUCLEAR MEDICINE

Clinical trials of boron neutron capture therapy for melanoma on the extremities were successfully continued up to the second dose level of 1250 RBE-cGy. Five irradiations have been completed. No adverse reactions have been observed on the subjects. However, three of the five lowest dose irradiations of deep seated melanoma have resulted in significant tumor regression. In one case a subject had two separate melanoma lesions irradiated at different times, two years later she is disease free in the irradiated areas.

Phase One studies of brain cancer, metastatic melanoma and glioblastoma multiforme were initiated. Eight volunteer subjects have been irradiated, and the third dose level of 1065 RBE-cGy has been reached. One serious adverse reaction was observed at one of the lower dose levels. It is unclear if this was due to the BNCT irradiation. Two of the eight brain tumor subjects have experienced improved performance following the experimental BNCT irradiation. One intracranial melanoma showed essentially complete regression. These trials are continuing.

A new high intensity and low background epithermal neutron beam has been designed for the MITR-II. The design is based on using spent fuel from the MITR-II in a fission converter concept. This beam would be able to irradiate patients in several minutes and would be suited for advanced clinical trials and routine therapy involving treatment of many patients per day. A \$2.5 M proposal to the US DOE to construct this facility has received approval. It is expected that upon completion of this new facility, MIT will possess the best neutron beam in the world for BNCT irradiations.

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.

RADIATION HEALTH PHYSICS

The NRL supports a subdiscipline in the Nuclear Engineering Department (NED), Radiation Health Physics, by providing relevant research opportunities and a specially designed laboratory/demonstration course. This course, 22.09-22.59 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.

DOSE REDUCTION AND COOLANT CHEMISTRY STUDIES

A Study of the electrochemical function of zinc injection under pressurized water reactor conditions was completed under the direction of Prof. Ronald Latanision and Dr. Gordon Kohse. Funding was provided by French Atomic Energy Center (CEA) and the project is part of a study of zinc injection chemistry under the auspices of a Czech-U.S. cooperative program.

IRRADIATION-ASSISTED STRESS CORROSION CRACKING

Use of the multiple specimen constant load test facility continued to study the urgent problem of core shroud cracking in boiling water reactors. Several thousand hours of testing were completed with a variety of materials including actual core shroud weld material from a U.S. reactor that was built but never operated. The system by which the identity of a broken specimen can be determined using cross-head displacement data was successfully

demonstrated. This program is under the direction of Dr. Gordon Kohse of the NRL and Professor Ronald Ballinger of the Nuclear Engineering Department and is funded by the Tokyo Electric Power Company and the Electric Power Research Institute.

SENSOR PROJECT

The sensor project specimens, nine instrumented crack growth specimens and companion electrochemical corrosion potential sensors, were shipped to the GE Vallecitos Nuclear Center for post-irradiation examination. The specimens and the titanium irradiation capsule in which they were shipped contained over 150 Ci of activity and the use of a dedicated, shielded shipping cask with underwater loading in the reactor spent fuel pool was required.

MITR RELICENSING AND REDESIGN

The relicensing of the MITR with a concomitant upgrade in power to 10 MW is in progress. During the past year, codes for the analysis of thermal-hydraulic performance were improved, and the preparation of relicensing documents was begun. The MITR's emergency plan was rewritten in its entirety and several chapters of the new Safety Analysis Report were completed. Also, system diagrams for the MITR are being updated and stored digitally. This work is under the direction of Dr. John A. Bernard, the NRL's Interim Director.

A new nuclear safety system, capable of 10 MW operation, has been purchased and is being installed. Also, new area and effluent radiation monitoring systems were installed.

REACTOR IRRADIATIONS AND SERVICES

In nuclear medicine, the development and/or continuing production of radioisotopes for use by researchers at hospitals and other universities included: 1) production of Dy-165 for Dr. Clement B. Sledge of Brigham and Women's Hospital for research studies in the treatment of arthritis; 2) investigations by Dr. David Slaughter of the University of Utah using track etching techniques to determine the uptake pattern of heavy metals by human as well as the environment; 3) evaluation of copper and gold for arthritis treatments by Dr. Alan B. Packard of Children's Hospital; and 4) study of neutronic behavior of acrylic rods doped with boron and lithium for use in neutron monitoring devices by Dr. John Doyle of Harvard University.

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: 1) Dr. Alan P. Fleer of Woods Hole Oceanographic Institute used irradiation to determine natural actinides and plutonium in marine sediments; 2) Dr. Robert Kaiser of Entropic Systems, Inc., is studying the irradiation of fluorinated oils; 3) Mr. Leonard Cirignano of Radiation Monitoring Devices, Inc., is investigating the effects of irradiation on liquid crystals; 4) Captain Daniel J. Robbins of the McClellan Air Force Base is investigating calibration of ultra-sensitive neutron monitoring devices by thermal neutron fission of uranium foils; 4) Dr. Gerjian P. Van Bakel of Northwestern University is studying neutron damage of Ni-Al alloys; 5) Dr. Claudia Stenstrom of Spire Corporation is investigating the effects of neutron irradiation on Hf-Zr alloys; 6) Dr. Susan Stone of the University of Maryland performed aerosol studies using neutron activation analysis; and 7) Dr. Eduardo J. Mantilla of Cambridge Scientific, Inc., performed γ -irradiation of 9-coated alumina fibers for medical application of human muscle replacement. Additional NAA services, including many for research groups outside MIT, are reported above in the section entitled Environmental Research and Radiochemistry.

Whereas most of the above 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 USDOE 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, 400 students and 50 faculty and staff from over 35 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: 1) use by Professors J. Christopher Hepburn and Rudolph Hon of Boston College to activate geological specimens and standards for the NAA of rare earth and other trace elements in studies of the geological development

of the northeastern United States; 2) irradiation of air particulate samples for NAA by Professor Gerald Koeler of the University of Michigan; 3) gamma irradiation of plant seeds for several area high school students participating in science fair projects; 4) measurements of boron concentration and work on high resolution track etch autoradiography for Professor Robert Zamenhof of Beth Israel-Deaconess Medical Center; 5) participation in several special high school student projects; 6) neutron activation analysis of subsurface water supplies by Professor Jack Beal at Fairfield University; and 7) neutron time-of-flight and Bragg angle measurements by Professor Martin Posner's group at the University of Massachusetts.

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. One local university incorporated reactor visits and experiments into its regular course curricula, as follows: The University of Massachusetts, Harbor Campus, Professor Martin Posner, Department of Physics, Physics (Course#603), 8 students, 3 visits.

MAJOR REACTOR SERVICES

A major project to neutron transmutation dope semiconductor grade silicon single crystals continued for a successful fourth year. Approximately 12 metric tons of Si crystals were accurately irradiated in shielded, automated irradiation facilities at the MITR-II. 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 39 there are currently five engineering and management positions held by minorities and women. The NRL participated in the USDOE's program for minority training in reactor operations, and one of our current senior reactor operators is a graduate of this program. Three women are currently in training to become licensed reactor operators.

MIT RESEARCH REACTOR

The MIT Reactor completed its 39th year of operation, its 23rd since the 1974-75 shutdown for upgrading and overhaul. The reactor originally operated on a Monday through Friday schedule. However, for the past several years the reactor has operated continuously (seven days per week) to support several major experiments related to the dose reduction studies. On average, the MIT Reactor was operated 98 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 396,342.69 megawatt-hours as of June 30, 1997. The MITR-I generated 250,445 MW in the sixteen years from 1958 to 1974.

To summarize briefly the reactor utilization described in more detail above, it was well utilized during the year, although still more experiments and irradiations can be accommodated due to the number and versatility of its many facilities. A modified version of the irradiation assisted stress corrosion cracking facility is installed and operating for long-term in-core irradiation. The number of specimen irradiations was 740. There were 30 irradiations in the medical room, most 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 15 and 30 per year, respectively. A total of 1278 people toured the MIT Research Reactor from July 1, 1996 through June 30, 1997.

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 44th year of operation in 1996-97. 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 a contemporary computational environment of workstations and micro computers.

This report summarizes the Center's 1996-97 activities and briefly reviews its educational, research and outreach programs.

FACULTY, STUDENTS, STAFF

Thomas L. Magnanti, George Eastman Professor of Management Science and Professor of Electrical Engineering and Computer Science and Robert M. Freund, Seley Professor of Operations Research at the Sloan School of Management, continued as Codirectors of the Center.

This year the ORC had 34 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 PhD and a master's degree. During 1996-97, these programs enrolled 41 students — 31 PhD candidates and 10 SM candidates. The Center conferred 7 master's degrees and 4 PhD's. Several other PhD theses were in the final stages of completion in the summer of 1997.

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.

Several affiliated faculty were active in significant educational development projects at MIT. Professor John Tsitsiklis (together with Professor Dimitri Bertsekas) have taken over the teaching of 6.041/6.431 and are revising the curriculum of this large MIT subject. Professors Amedeo Odoni, Thomas Magnanti, Lawrence Wein, and Senior Lecturer Donald Rosenfield taught in MIT's first degree-granting distance learning program, System Design and Management (SDM). Professor James Orlin is undertaking significant changes in the Sloan undergraduate subject offerings in operations research.

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 1996-97, for example: the National Science Foundation; C.S. Draper Laboratory (several projects and Draper Fellowships); Federal Aviation Administration; Logistics Management Institute; MITRE Corporation; Office of Naval Research; and the United Parcel Service Foundation.

OUTREACH AND PROFESSIONAL SERVICE

In its effort to serve the professional community at large, the ORC regularly undertakes a number of outreach activities.

The ORC faculty offered one professional course during the 1996 summer session: "Airport Systems: Strategic Planning and Detailed Design."

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: Michael Trick (Carnegie Mellon); Moshe Rosenwein (AT&T); Patrick Jaillet (U. of TX); Karla Hoffman (George Mason); Richard Cottle (Stanford Univ.); Warren Powell (Princeton); Patrick Harker (Univ. of PA); Rekha Thomas (Texas A&M); Michael Ball (U. of MD); Mark Spearman (GA Inst. of Tech); Irv Lustig (CPLEX Optimization); Paul Glasserman (Columbia); Iraj Saniee (Bellcore); Carol Redfield (DFI); Murad Taquq (Boston Univ.); Ann Gray (Harvard); Michael Overton (NYU); Collette Coullard (Northwestern); Nabil Kahale (AT&T); and Laszlo Lovasz (Yale).

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 Charles Marge (CSC Consulting); Richard Staats (Logistics Management Institute); and Theodore Theodosopoulos (BayBank Systems).

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. This year the ORC's active affiliated faculty members included two women, but no under-represented minorities. 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.

The Center's graduate students are diverse, representing over 19 countries. In keeping with the Center's tradition of seeking and attracting outstanding women, the number of female students has consistently averaged about 30%.

While the ORC enjoys significant international and gender diversity, it has attracted very few under-represented minorities as students. In order to enhance the enrollment of under-represented minorities, we have begun a number of outreach activities. A working group of faculty, students, and staff has been convened to formulate a plan of action. Among steps already undertaken, we have engaged three faculty in the MIT Minority Summer Research Program, we are designing literature to promote the MIT ORC to minority undergraduates, and we are planning to send students and faculty to targeted campuses in the US in order to enhance the applicant pool of under-represented minorities.

PROFESSIONAL ACTIVITIES

The ORC-affiliated faculty and students continue to assume positions of leadership and receive many awards within the Operations Research and Management Science community. During 1996-97, several ORC-affiliated faculty became Chaired Professors: Amedeo R. Odoni was awarded the T. Wilson Boeing Chair of Aeronautical Engineering; James B. Orlin was awarded the Edward Pennell Brooks Professor of Management Chair; Dimitris Bertsimas and Lawrence Wein were awarded Leaders for Manufacturing Professorship Chairs; and Robert Freund was awarded the Seley Professor of Management Chair. Professor Arnold Barnett received an Award for Excellence in Management Education and Robert Freund was awarded the 1997 Teacher of the Year Award, both from the Sloan School of Management. ORC faculty, students, and alumni received numerous other awards: Arnold Barnett was the recipient of the first INFORMS President's Award. (The award recognizes outstanding contributions to the betterment of society.) Jiang Wang was awarded the Leo Melamed Prize by the University of Chicago's Graduate School of Business. (This prize is awarded every two years for significant scholarly achievement in financial

economics.) Keely Croxton, a current ORC graduate student, was the recipient of the Dwight David Eisenhower Graduate Fellowship Award from the US Department of Transportation. Stefanos Andrea-Zenios, an ORC alumnus, won first place in the 1997 INFORMS Nicholson Student Paper Competition. Sarah Stock Patterson, a recent graduate of the ORC, was a finalist in that competition. John Tsitsiklis and Dimitri Bertsekas were awarded the 1997 INFORMS/CSTS Award for their book, *Neuro-Dynamic Programming*. (This award is given by the computer science technical session of INFORMS for research excellence in the interface between operations research and computer science.) Josephine Kintanar, an ORC alumna, was one of the four winners of the 1997 Franz Edelman Award. Mitchell Burman, an ORC alumnus, and Stanley Gershwin received honorable mention for the 1997 Franz Edelman Award. Thomas L. Magnanti received an honorary doctorate from the University of Montreal and also received the honor of becoming an Institute Professor at MIT.

More information about the Operations Research Center can be found on the World Wide Web at the following URL: <http://web.mit.edu/orc/www>.

Robert M. Freund, Thomas L. Magnanti

PLASMA SCIENCE AND FUSION CENTER

The primary objective of the Plasma Science and Fusion Center (PSFC) is to provide research and educational opportunities to develop a basic understanding of plasma behavior, and to exploit that knowledge by developing useful applications. The central focus of the activities at the PSFC has been to develop a scientific and engineering base for the development of fusion power. Nevertheless, nonfusion applications involving plasmas at the PSFC are numerous and diverse. A recent example is the significant growth of programs in hot and cold plasma processing of waste materials. To give recognition to the wide range of plasma research, and the new emphasis at DOE on plasma and fusion science, as of January 1, 1997, we changed the Center's name to "Plasma Science and Fusion Center."

The Plasma Fusion Center is recognized as the leading university laboratory in developing the scientific and engineering aspects of magnetic confinement fusion and related plasma science and technology. Its research programs continue to produce significant results on several fronts: (a) experimental confinement research on the Alcator C-Mod tokamak (investigations of the stability, heating, and transport properties of compact high magnetic field, diverted plasmas), (b) the basic physics of plasmas (plasma theory, theoretical support of ITER and IGNITOR, new confinement concepts, nonneutral plasmas, coherent EM wave generation, development of high-temperature plasma diagnostics, basic laboratory and ionospheric plasma physics experiments, and novel diagnostic of inertial fusion experiments), (c) a broad program of fusion technology and engineering development that addresses problems in several areas (e.g., magnetic systems, superconducting materials, fusion environmental and safety studies, advanced millimeter-wave sources, system studies of fusion reactors, including operational and technological requirements), and (d) a significant activity of environmental waste treatment using plasmas.

The Plasma Fusion Center R&D programs are supported principally by the Department of Energy's Office of Fusion Energy Sciences. There are approximately 277 personnel associated with PSFC research activities. These include: 18 faculty and senior academic staff, 40 graduate students and 30 undergraduate students, with participating faculty and students from Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, Nuclear Engineering, and Physics; 80 research scientists and engineers and 40 visiting scientists; 36 technical support personnel; and 27 administrative and support staff.

Our Center enjoyed considerable scientific success and a modest increase in funding this year. All programs were funded at a stable level this year, with a modest decline in engineering activities, and a modest increase in fusion science research. Our staff has been aggressive in submitting new research proposals to a number of new initiatives launched by DOE and NSF.

ALCATOR DIVISION

The Alcator Division, led by Prof. Ian Hutchinson, carries out experimental research on Alcator C-Mod, a compact, high-performance, high magnetic field divertor tokamak devoted to investigating the physics of high temperature magnetically confined fusion grade plasmas. The total staff of the Alcator Project is about 95, including 16 full-time research physicists, 2 faculty members and 20 graduate students.

Alcator C-Mod is now established as one of the two major U.S. tokamak facilities, along with DIII-D at General Atomics, San Diego. It is also recognized as one of the five key divertor tokamaks in the world. Alcator C-Mod is the only diverted high-field compact experiment in operation, and therefore it plays a unique role in providing critical tests of confinement scaling and theory at high power density. Alcator C-Mod is thus extremely favorably placed to contribute vital information to fusion science research, and to do so in a highly cost effective way because of its compact approach. Because of its high power density, C-Mod will contribute uniquely to ways of achieving ignition at low cost, and of exploring advanced tokamak physics regimes. Its vertical plate divertor geometry has been adopted as the reference design for ITER, and its shape is essentially the same as that envisioned for ITER. It also is presently unique in having high-Z metallic plasma facing components. Such components are planned for ITER.

Alcator's role as one of the two national centers for tokamak research has begun to develop rapidly with the arrival of substantial collaborative contingents from the University of Texas and from the Princeton Plasma Physics Laboratory. Some challenges in adjusting to this somewhat broader national role are to be expected. Funding at MIT grew to \$11.5M in FY97 and is expected to rise again in FY98 but still not back to the FY95 level of about \$16M. The operation of the facility is therefore still highly constrained despite the assistance of collaborators. This was

particularly noticeable during the past year when operations were curtailed by funding and the project concentrated on completing maintenance and inspection together with preparations for this year's campaign and analysis of data.

Several important discoveries were made. It was found that the plasma naturally enters an operational regime called Enhanced D-alpha, in which the energy confinement is high but the edge particle confinement is modest. This is ideal for a reactor or next-step experiments in which we wish to keep the energy in but allow impurities or helium ash to escape from the plasma. Detailed physics studies to identify the processes involved in this phenomenon are just beginning.

The presence of strong collisional recombination of the plasma in the tokamak divertor was established experimentally for the first time through spectroscopic measurements on C-Mod. This mechanism is now considered an important part of "divertor detachment", the process whereby plasma heat and particle flux to the solid surfaces of the divertor chamber is greatly reduced. Future fusion reactors need to use such processes to spread the escaping heat load more uniformly across the plasma-facing components. Our ongoing research in divertor physics will continue to study detachment, and various new edge diagnostic measurements are coming into operation that will help us to understand it. In addition we are concentrating on improving our understanding of plasma and neutral flow in the divertor, expecting that such physics knowledge will enable improved divertor designs to be developed.

Alcator data and analysis has been critical to resolving some important design questions for ITER. Our data dominates the "disruptions" database collected by ITER. Analysis of this database has enabled ITER to develop a credible mechanical design of its structures to withstand disruptions and their asymmetries (first established by Alcator experiments). C-Mod's transport data also is very important to reducing the uncertainties in the energy confinement predictions for ITER. Such information is a key element in predicting whether ITER will ignite and how much auxiliary heating is needed. Our compact size and high magnetic field place C-Mod in a unique but important area of the multidimensional space within which tokamaks operate, and our data has reduced by about a factor of 2 the statistical uncertainty in the extrapolation to ITER from current experiments.

In the coming year, the Alcator group will be submitting the proposal to DOE for the next five years of our research. This process will help to cement our position as a key fusion research facility. We anticipate that the strategic vision of our program will emphasize the opportunities of the high-field compact tokamak approach, maintaining our unique contributions in transport and divertor physics, and moving forward both to higher performance plasmas and to so-called "advanced tokamak" studies in which enhancements are obtained and understood by controlling the internal profile of current, pressure, and velocity of the plasma.

Student involvement in the project remains strong. Several doctoral projects were recently completed with students moving to research positions both in fusion and beyond. We anticipate maintaining the current student numbers in the foreseeable future since Alcator is the foremost university-based plasma fusion experiment and the education of future generations of plasma physicists and engineers is so important.

PHYSICS RESEARCH DIVISION

Headed by Prof. Miklos Porkolab, this Division seeks to develop a theoretical and experimental understanding of plasma physics and fusion science. This Division is also a base for developing new confinement concepts, exploring inertial fusion energy and space plasma physics. Owing to the reorientation of the fusion program to a more science based activity, the funding of the activities of this Division remained relatively stable.

FUSION THEORY AND COMPUTATIONS

DIVERTOR AND EDGE PLASMA PHYSICS THEORY

Dr. Dieter Sigmar and co-workers focus local resources on analytic and numerical investigations of edge plasmas while continuing to lead the national Divertor Task Force. Observations from the Alcator C-Mod tokamak and other devices are used to develop an improved understanding of basic plasma physics phenomena as well as advance the Alcator physics program. The goal of this effort is to find ways to divert the severe heat flux impinging on the first wall while simultaneously maintaining good plasma purity in present and planned experimental fusion devices.

The only neutral atom-plasma fluid code capable of modeling current tokamaks and fusion reactor relevant high density divertor regimes was developed by this group and is currently being used to explore changes in the C-Mod

divertor geometry aimed at improving control of neutral atoms. This code was recently extended to treat enhanced recombination of plasma into neutrals occurring in the presence of molecular hydrogen, and experimental verification by collaborators quickly followed. The group's studies have also proven that simple size scaling arguments based on binary collisions are inappropriate in the divertor and that detailed scaling information obtained from numerical simulations is more favorable. The group continues to develop (i) a hybrid Monte Carlo - Navier Stokes neutral gas code retaining the nonlinear effects of neutral-neutral collisions and (ii) kinetic Fokker-Planck and particle-in-cell codes that model features of charged particle distribution functions not described by fluid codes.

ADVANCED TOKAMAK PHYSICS AND MHD STABILITY THEORY

Dr. Jay Kesner and collaborators from Columbia University (Prof. Mike Maul) have been exploring the possibility of the dipole magnetic field geometry as a potential attractive magnetic confinement concept for fusion. It was suggested in 1987 by Hasegawa that a dipole might provide a considerably simpler confinement scheme for fusing plasmas. Dipole confinement is observed in nature (in the earth's and the jovian magnetospheres) and in fact this suggestion was based on an increasing understanding of magnetospheric confinement. Satellite measurements have shown that in magnetospheric plasmas the ratio of plasma pressure to magnetic field pressure can exceed unity and these plasmas appear to be relatively quiescent. Conceptually this concept offers several potential improvements vis-à-vis a tokamak as a fusion reactor. It is inherently steady state and free of disruptions. The concept presents a challenge to engineering, primarily the shielding of the superconducting ring from the fusion generated heat and radiation.

We have submitted a joint proposal with Columbia University (Prof. Michael Mauel) to the DOE-OFES to construct a concept exploration experiment in the Nabisco Laboratory at MIT. The project envisioned would extend over a 5 year period and cost approximately \$5 M, with approximately \$3M coming to MIT for construction and operations and the \$2M research budget equally shared between MIT and Columbia University. This project will be oriented towards basic plasma physics and it is expected to include strong student involvement.

We have also begun theoretical studies of dipole confinement including studies of the stability of low frequency fluctuations and magnetohydrodynamic stability. Additionally we (Drs. Leslie Bromberg, Jay Kesner) have submitted a proposal to DOE-OFES to perform a system study of a levitated dipole based fusion reactor. Such a reactor would burn "advanced" fuels (such as D^3He) and therefore would be more environmentally benign.

Other theoretical research includes: (1) transport scaling in an RFP (Prof. Jeffrey Freidberg and Antonio Bruno, Italy): A simple model has been proposed to explain the empirical energy confinement time observed in Reversed Field Pinch (RFP) experiments; (2) continued exploration of the Advanced Tokamak (Drs. Paul Bonoli and Jesus Ramos, Prof. M. Porkolab), with reversed shear and high bootstrap current fraction using off-axis current drive with either lower-hybrid waves or fast-wave/Bernstein wave mode-conversion. Detailed code prediction have been obtained and published recently, and these estimates are being incorporated in the latest C-Mod 5-year proposal cycle.

In a new theoretical initiative, we have set up a collaboration with Prof. Anders Bondeson of the Chalmers University, Sweden who has developed the highly sophisticated resistive MHD code, MARS. This State of the art numerical code has been adapted to analyze the MHD stability of Alcator C-Mod discharges (Dr. Ramos). Comprehensive experimental data are used to generate a best fit MHD equilibrium model of the Alcator C-Mod plasma. This is linked to linear stability codes to investigate ideal and resistive MHD instabilities that may explain plasma fluctuations and disruptions. Work during the past year has concentrated on a set of significant Alcator c-mod shots from the spring of 1996 campaign, with internally reversed magnetic shear profile. The code has explained the experimentally observed MHD fluctuations in the Reversed Shear mode of operation of C-Mod.

PLASMA THEORY APPLIED TO SUPERCONDUCTORS

This effort is spear-headed by Prof. Jeffrey Freidberg. (1) A theory has been derived which describes a robust mechanism for the observed ramp rate limitation in high field superconducting magnets (with Drs. Matthew Ferri and Ali Shajii). It explains why such magnets quench significantly below their predicted DC current limit during rapid ramping of the current. (2) A continuum theory has been formulated and analyzed with the goal of calculating AC losses in multistrand superconducting cables used for fusion magnets, a critical problem during current ramping (with Judy Chen and James McCarrick). (3) A theory has been derived to describe the thermal hydraulic behavior of superconducting magnets with a central cooling channel. It is shown that two channel (or multi-channel) systems

can be reduced to an equivalent single fluid model whose properties include anomalously large (i.e. a factor of 100) thermal and particle diffusion coefficients (with Dr. Shajii). (4) In a new initiative (Magnetic Field Mapping, with Drs. A. Shajii and J. Jayakumar) a novel procedure has been suggested for mapping the magnetic fields in large detectors used in high energy physics detectors. The method is fast, accurate and economical with respect to existing techniques. It makes use of analogous surface mapping procedures used widely in the magnetic fusion community. The procedure is being currently implemented on the PHENIX detector at Brookhaven Laboratory.

PLASMA RF THEORY GROUP

The Plasma Theory Group under the direction of Prof. Abraham Bers and Dr. Abhay K. Ram have proposed new means for plasma heating and current drive in the National Spherical Tokamak Experiment (NSTX), which is currently being designed by a national team as the next fusion research facility at the Princeton Plasma Physics Laboratory. NSTX, an alternative concept to the tokamak, is characterized by stable operation at high-beta's (plasma pressure/magnetic pressure) which have a complex magnetic field structure at high plasma densities. This requires new means for RF heating and driving current in such plasmas. The new proposed RF heating is for the electron-cyclotron range of frequencies and is based upon analytical work on a new wave conversion process that this group pioneered.

PLASMA PHYSICS EXPERIMENTS

IONOSPHERIC PLASMA RESEARCH

The Ionospheric Plasma Research Group (Dr. Min-Chang Lee and students) has been conducting laboratory experiments on the Versatile Toroidal Facility (VTF) at PSFC and ionospheric plasma heating experiments at the Arecibo Observatory. These experiments, aimed at investigating wave-plasma interactions and plasma turbulence, can effectively cross-check the results obtained in tenuous space plasmas and dense laboratory plasmas. A recent paper, published in the *Geophysical Research Letters* (Vol. 24, No. 2, pp 115-118, 1997) by Lee et al., reports the VTF laboratory reproduction of Arecibo results, confirming a theory of nonlinear wave scattering developed by Dr. Min-Chang Lee and coworkers. The key experimental results were published on the issue cover. New proposals have been submitted to NSF/DOE/DOD for laboratory simulation and radar experiments on space plasma phenomena, advancing the space weather research. A series of plasma heating campaigns, using the upgraded NSF radio facilities and the PSFC student-built antennas and receivers, will be conducted in July, October, and November, 1997 and February, 1998 at Arecibo, Puerto Rico and Trelew, Argentina.

INERTIAL CONFINEMENT FUSION EXPERIMENTS

Exciting progress has occurred in high-energy-density plasmas and in inertial confinement fusion. MIT is playing a prominent role in the design of novel experiments for the National Ignition Facility (NIF), a 1.2 billion dollar facility at Lawrence Livermore National Laboratory (LLNL). The goal of the NIF is to produce 10 times more fusion energy than the input laser energy used to compress the fusion capsule. MIT, with colleagues at LLNL and University of Rochester, developed and recently published in *Physical Review Letters* a novel means to measure the implosion symmetry and core conditions for NIF implosions. Densities of 1000 g per cubic cm and pressures greater than 300 billion atmospheres are anticipated. In comparison, solar core density and pressure is 150 g per cubic cm and 240 billion atmospheres, respectively. Or, at earth center, the pressure is a paltry 3.6 million atmospheres.

After 5 years of design, testing, and construction, MIT's large spectrometer is to be interfaced to the Omega laser fusion experiment at the University of Rochester. By measuring an array of nuclear products—alphas, tritons, deuterons, we can infer the core conditions—pressure, density, temperature—of the implosion, as well as the symmetry of the implosion, i.e., how spherically it converges when it implodes to a radius about 10 times smaller than before the lasers compress the fusion capsule. Utilizing compact spectrometers—small versions of the large one—we have already been obtaining important data on acceleration mechanisms, never seen before, that are occurring within the fusing capsule. The interfacing of the MIT's large spectrometer is an exciting time for physicists throughout the fusion program since it has the unique capability of probing, for the first time, stellar-like conditions created in inertial fusion.

PHASE CONTRAST IMAGING ON DIII-D

Owing to the successful results, this collaborative effort between General Atomics and MIT (Prof. Miklos Porkolab, Dr. Stephano Coda and now Dr. Peter O'Shea) has enjoyed a new period of 3-year funding cycle. Dr. Coda, who

completed his Ph.D. thesis last winter and returned to Europe (Lausanne, home for the Swiss National Fusion Laboratory), has been replaced by Dr. O'Shea, a recent MIT Physics Department graduate from Alcator C-Mod. Through careful studies over the course of several years, the properties of edge turbulence have been mapped out by Dr. Coda. The novel observation of the existence of radially propagating modes has been found to be in agreement with recent analytical and numerical code predictions on the global structure of a class of plasma instabilities (ITG modes) that are considered to be a dominant component of transport enhancing turbulence. For his pioneering studies, Dr. Coda won the 1997 APS-Division of Plasma Physics Outstanding Thesis Award. Dr. O'Shea is upgrading the experimental installation to comply with new safety regulations, and will continue the experiments in the next fiscal year.

SMALL TOKAMAK AS A SOURCE OF X-RAY RADIATION FOR LITHOGRAPHY

A joint MIT-Princeton University Program (Profs. M. Porkolab and S. Suckewer), this experiment is aimed to explore the possibility of using low temperature tokamak plasmas as a source of radiation near 13 nm for lithography applications. In the past year, scoping experiments were carried out to test two new filters in front of the multi-layer mirror and bolometer setup to determine the increase in the emitted radiation due to injection of high Z gases, such as Ar, Kr, Se and carbon from graphite rods. The results are being analyzed now. Progress in this experiment has been slow due to the busy schedule of the Principal Investigators and the unavailability of permanent staff and funding.

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.

GYROTRON RESEARCH

The gyrotron is a novel source of microwave, millimeter wave and submillimeter wave radiation. It uses a helical electron beam in a high magnetic field to generate radiation by stimulated emission at the electron cyclotron frequency. Gyrotrons are under development for electron cyclotron heating (ECH) of present day and future plasmas as well as for high frequency radar. These applications require tubes operating at frequencies in the range 100-300 GHz at steady-state power levels approaching 1 MW. The gyrotron research group is led by Dr. Kenneth Kreischer. In 1997, research has concentrated on investigating the physics issues, including mode competition and beam quality, which affect the efficiency of operation of high power, high frequency gyrotrons. We have completed the first phase of a program of research to demonstrate a high power, high frequency gyrotron suitable for application to the International Thermonuclear Experimental Reactor (ITER). A prototype experiment at M. I. T. has been built and has demonstrated a power level of 1.5 MW power level at a frequency of 170 GHz with an efficiency of over 35%. A novel mode converter for this gyrotron has been built and tested. Future work will concentrate on increasing the efficiency of the gyrotron to close to 70% using depressed collectors. A program of research is also underway to demonstrate a 140 GHz coaxial cavity gyrotron. The coaxial cavity gyrotron may be capable of higher power than conventional cavity gyrotrons, up to 3 MW. 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. In 1997, a new research program was initiated to develop a 250 GHz gyrotron for use in electron spin resonance and nuclear magnetic resonance studies. This research, funded by NIH in collaboration with Prof. R. Griffin of the Magnet Lab, is a pioneering effort in high frequency spin resonance studies. In the future, we hope to initiate a program of gyrotron amplifier research.

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 GHz klystron power source drives the electron gun. This 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 which can reach the TeV range of energies.

In 1997, initial operation of the RF gun was achieved. This is the first photocathode electron gun to operate at a frequency above 2.856 GHz. Such electron guns have the potential for achieving record high values of electron beam

quality. Conditioning of the cavity allowed operation of the gun at surface fields of up to 250 MV/m before dark current and breakdown were observed. Using 10-20 μ J, picosecond pulses from a Ti:sapphire laser tripled to 267 nm, electron bunches of 0.1 nC were obtained with energies exceeding 1 MeV. In the next phase of this research, we will install and test a high gradient accelerator to achieve beam energies of about 30 MeV. This research should establish 17 GHz as a feasible frequency for future TeV electron colliders.

THEORETICAL RESEARCH

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 (CARM, FEL, gyrotron, relativistic klystron, relativistic TWT), intense beam transport and beam halo formation, beam-beam interactions, cyclotron resonance accelerators, two-beam accelerators, photocathode design, and other 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.

PLASMA TECHNOLOGY DIVISION

The mission of the Plasma Technology Division (led by Drs. Daniel Cohn and Paul Woskov) is to develop new plasma technology applications with particular emphasis on environmental applications; to develop new fusion diagnostics; and to develop new fusion system concepts.

The Division is developing microwave plasma spectrometer systems for continuous monitoring of metals emissions from plasma furnaces, incinerators and other technologies for treatment of waste at DOE sites. The microwave plasma spectrometer approach has unique capability for meeting DOE needs of real time situ measurements. The Division is also developing plasma technology for conversion of hydrocarbon fuels into hydrogen rich gas. It is investigating the use of plasma produced hydrogen-rich gas for pollution reduction in both stationary power and vehicular applications. Application to pollution reduction from internal combustion engines could have an important impact on air quality. In addition, plasma conversion of difficult to use biofuels into readily usable clean combustion fuels is being investigated.

During the last year substantial progress has been made in developing a real time calibration of the microwave plasma continuous emissions monitoring. An advanced, high-resolution multiband spectrometer system has also been developed to facilitate simultaneous multimetals measurements. In the area of plasma generation of hydrogen rich gas, a major improvement in conversion efficiency and in electrical power requirement has been achieved. In addition, initial experimental studies of plasma conversion of biofuels have produced promising results.

During the next year, field testing of the microwave plasma continuous emissions monitor is planned. In the area of plasma generation of hydrogen-rich gas, a new program is underway to investigate vehicular applications. This program will be funded by the DOE Office of Transportation Technologies and will be carried out in collaboration with Battelle Pacific Northwest National Laboratory.

Paul Woskov has been notified that he will receive a 1997 R&D 100 award. The Award will given for development of a refractory corrosion monitor. The monitor will provide remote real time measurements of refractory corrosion, a key issue in furnaces for waste treatment and other applications. Paul Woskov, Dan Cohn and other members of the Plasma Technology Division have also received R&D 100 Awards in 1994 and 1995.

TECHNOLOGY AND ENGINEERING DIVISION

The Technology and Engineering Division is headed by Joseph Minervini and comprises 35 engineers, scientists and administrative and support staff. It supports graduate and undergraduate students in the Nuclear Engineering, Mechanical Engineering, Electrical Engineering and Computer Science, and Materials Science and Engineering departments.

This year most of the Division's work continued to focus on magnetics R&D for, the International Thermonuclear Experimental Reactor (ITER). The principal effort has involved design and manufacture of the Central Solenoid Model Coil. This is a joint US-Japanese-European effort and MIT manages the US portion of the design and construction. Extensive collaboration with U.S. industries continued and includes subcontracts with Lockheed

Martin, Wall-Colmonoy, Martinez and Turek, INCO Alloys International, and Intermagnetics General Corp., among others. A site leased in Hingham, MA allows PSFC engineers and technicians to perform critical of the coil fabrication, for example, insulating the magnet turns, and terminating the conductors.

In-house research for ITER concentrates on superconductor development, subscale testing, and magnet design and analysis. Significant results continue to be obtained in understanding the stability limitations of fast ramping the superconducting coils and an understanding of current distribution and crossover from strand to strand within a conductor is continuing. The Pulse Test Facility (PTF), has been completed and commissioned for pulse testing of large size superconductors and joints for ITER. The first US prototype joint was tested successfully and tests of joints from other ITER partners are now in process. This activity will continue into FY98. Prof. Ron Ballinger's Materials Science and Technology Group continues an expanded ITER task for detailed mechanical characterization of the superalloy Incoloy 908 which was initially developed in his laboratory. Results to date have removed much of our ITER partners' concern over the use of this material in the conduits for the ITER cable-in-conduit conductor.

At this time, the main ITER program funding appears secure for 1998, but the Technology and Engineering Division continues to seek new programs outside the Department of Energy supported fusion program. New initiatives have resulted in funding through INEL for a large scale, electromagnetic seismic simulator platform, and from the US Navy for design and analysis of conductor types for a Superconducting Magnetic Energy Storage magnet. The Division is playing an active part in conductor and magnet design for the Korean KSTAR tokamak. This work takes place in conjunction with the Department of Energy under a recently signed U.S. - Korea bilateral research agreement. As KSTAR will be similar to TPX in scope and design this is a good match to our relevant experience from the TPX and ITER programs. The Division also has active proposals in several other areas of magnet technology, for example, open structure MRI imaging systems, and magnetic separation, which are likely to result in maintenance of near level personnel support into the next fiscal year.

EDUCATIONAL OUTREACH PROGRAMS

The Plasma Science and Fusion Center has established an educational outreach program primarily focused on heightening the interest of K-12 students in scientific and technical subjects. The Mr. Magnet Program, headed by Technical Supervisor Paul Thomas, brings a traveling demonstration on magnetism into local elementary schools, inspiring and exciting students with the chance to take part in hands-on experiments with magnets. Over the past year he has worked with over 15,000 students. This year his outstanding service to the local area and to the MIT community earned him MIT's Billard Award. The Department of Energy has been so impressed with this program that they have directed the PSFC Director to fund half of Paul Thomas' salary for outreach activities using available DOE funds. We have also received contributions to the program from local businesses and foundations, allowing us to explore the possibility of creating video materials to leave with schools, showing young students participating in classic magnetic experiments.

The PSFC also seeks to educate 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 PSFC continues to work with other national laboratories to educate students and the general public. An Annual Teacher's Day and Open House has become a tradition at each year's APS meeting. The 1996 event in Denver was the result of a year of planning involving the local education community and representatives from various Laboratories. Education Outreach Coordinator Paul Rivenberg is involved with the planning of the 1997 event in Pittsburgh, in preparation for MIT's larger organizational role in the 1998 APS meeting in New Orleans. A similar outreach event is also being planned for the Spring of 1998 in Washington, DC, with support from the Coalition for Plasma Science.

The Coalition for Plasma Science is a new organization formed by members of universities and national laboratories, to promote understanding of the field of plasma science. Assistant Director Richard Temkin 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. Toby Smith of MIT's Washington

Office, has been elected Acting Chairman of the Coalition. This group was responsible for overseeing a general educational exhibit about plasma and its uses, which was presented in the Cannon House Rotunda in April.

APPOINTMENTS AND PROMOTIONS

During the past year, there have been several important appointments and promotions in Plasma Science and Fusion Center program areas.

Appointments: The Office of Resource Management appointed Peter Brenton as Fiscal Officer, Helene Keating as Headquarters Financial Administrator, Michael Majors as Fiscal Systems Manager, Winifred Nwangwu and Lorraine Ng as Assistant Fiscal Officers. In the Physics Research Division the appointments included Cristina Borrás Senabre and Peter O'Shea as Postdoctoral Associates. The Alcator Project's appointments included Edward Eisner, John Heard and Darren Garnier as Postdoctoral Associates, Donald Heiman as Optical Engineer, Dmitri Mossessian as Research Scientist, Yuriy Rokham as Electrical Systems and Controls Engineer, Eric Taylor as Mechanical Engineer, David Terry as Power Systems Engineer, and Stephen Wukitch as Research Scientist. The Fusion Technology and Engineering Division appointed James McCarrick as Postdoctoral Associate, Tamara Galen and Alla Terentieva as temporary Engineers, and Alexander Zhukovsky as Research Engineer.

Internal Promotions: In the Office of Resource Management, Thomas Hrycaj was promoted to Administrative Officer and Paul Rivenberg to Public Relations and Outreach Coordinator. The Alcator Project promoted William Beck to Head of Mechanical Systems Development, Vincent Bertolino to Power Systems Engineer and Group Leader, William Cochran to Power Engineer, Richard Murray to Diagnostics Systems Engineer, and Frank Silva to Operations Coordinator. The Fusion Technology and Engineering Division promoted Gary Dekow to Technical Facility Operator, and Ali Shajii to Research Scientist. During the past year, there were three Institute research promotions in the Plasma Science and Fusion Center: Prof. Jeffrey Freidberg, Associate Director, Dr. Joseph Minervini, Principal Research Engineer, and Dr. Richard Temkin, Assistant Director. The Plasma Fusion Center has also hosted 63 Visiting Scientists, Engineers and Scholars, and Research Affiliates during the past year.

GRADUATE DEGREES

During the past year, the following departments granted students degrees with theses in plasma fusion and related areas: Electrical Engineering and Computer Science: Judy Chen, Ph.D.; and Felicísimo Galicia, M.S. Mechanical Engineering: Kevin McFall, M.S.; Hana Ohkawa, M.S.; and Felicísimo Galicia, M.S. Nuclear Engineering: Matthew Ferri, Ph.D.; Daniel Lo, Ph.D.; James McCarrick, Ph.D.; and Steven Vitale, M.S. Physics: Stefano Coda, Ph.D.; Takuji Kimura, Ph.D.; Peter O'Shea, Ph.D.; Catherine Riconda, Ph.D.; Seth Trotz, Ph.D.; and Paul Stek, Ph.D.

We take this opportunity to wish these graduates success in their future professional endeavors.

More information about the Plasma Science and Fusion Center can be found on the World Wide Web at the following URL: <http://www.pfc.mit.edu/>.

Miklos Porkolab

RESEARCH LABORATORY OF ELECTRONICS

The Research Laboratory of Electronics (RLE), the Institute's oldest interdisciplinary research laboratory, was founded in 1946 as the natural evolution of the wartime MIT Radiation Laboratory. Initially, RLE was formed to bring together interests in physics and electrical engineering to work on problems in electromagnetic radiation, circuits, and specialized vacuum tubes. Over the years, RLE's research interests have branched out in many directions and, in fact, several of these interests have precipitated the formation of additional laboratories. Research within RLE is conducted by approximately 55 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 200 graduate students and 75 undergraduates have worked on research projects within RLE. Major support is derived from the Joint Services Electronics Program (JSEP) of the Army, Navy, and Air Force; other Defense Department 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, many research projects are funded through industry and private foundations. Although RLE has a very heterogeneous character, its organization is composed of two major thrusts and several smaller focus areas. One major thrust is centered on electronics and optics, and the other is centered on language, speech, hearing, and sensory communication. Each of the smaller focus areas often has substantial overlap with other research in RLE.

In the following remarks, several research highlights from 1996 are mentioned. The interested reader can obtain further information from *RLE Progress Report No. 139*, which describes research activities during calendar year 1996.

ELECTRONICS AND OPTICS

MATERIALS AND FABRICATION

Professor Jesús del Alamo has developed a physics-based model that predicts off-state breakdown voltage of high-electron mobility transistors over a large temperature range and for different device designs. This model will be useful in the design of high-power transistors in extreme temperature ranges, such as those in satellites. Professor Clifton Fonstad has demonstrated for the first time a high-efficiency indium-gallium arsenide-phosphide light-emitting diode that is monolithically integrated on a custom-designed, commercially processed integrated circuit. In this way, a research foundry for optoelectronic integrated circuits is able to provide high-performance digital electronic circuits that are seamlessly combined with optical emitters and detectors. Professor Leslie Kolodziejksi has devised techniques to prepare the gallium arsenide surface prior to regrowth for these optical devices, and has implemented phosphorus-containing materials in the light-emitting device structure. She has also fabricated novel channel-dropping filters and various photonic band-gap structures to manipulate light at optical frequencies in microphotonic systems. This includes the ability to guide light at 90-degree angles with no loss and with curvatures on the order of the wavelength of the light being guided.

QUANTUM-EFFECT DEVICES

Professor Henry Smith demonstrated a new paradigm for electron-beam lithography called spatial phase-locked e-beam lithography. This can achieve a pattern placement precision of approximately 4 nanometers, which is more than an order of magnitude improvement over conventional electron-beam lithographic methods. He also fabricated an array of magnetic posts in nickel with an areal density of 2.5×10^9 per cm^2 . The goal of this project is to make quantized magnetic storage devices with densities as high as 40 billion bits per square centimeter. This project is being conducted in collaboration with Professor Kamal Youcef-Toumi of the Department of the Mechanical Engineering and Professor Caroline Ross of the Department of Materials Science and Engineering. Professor Xiao-Gang Wen has investigated the dynamical properties of a coupled quantum dot that couples to one or more leads. The equation of motion for this system indicates that some electrons can tunnel through a dot via different intermediate states, and that different tunneling paths can interfere with each other. However, in some cases, the coupling to the leads may destroy this quantum interference effect inside the dot.

OPTICS AND DEVICES

Professor James Fujimoto has developed a new medical imaging diagnostic technique called optical coherence tomography. This technique functions as a type of "optical biopsy" and can produce high-resolution images of tissue

microstructure. It has been applied to many biological tissues including the retina, coronary arteries, and neural tissue. Professor Fujimoto has also investigated new short-pulse generation techniques based on the use of semiconductors and other materials with a nonlinear optical response that are used to initiate short-pulse generation. Professor Peter Hagelstein demonstrated the ability to focus precisely in long, low-density laser plasmas in gas. This is appropriate for the development of gain in a neon-like laser operating at 47 nanometers, and will be useful in various applications including deep-ultraviolet lithography and new surface analytical techniques. Professor Hagelstein has also been studying anomalies in metal hydrides, where it is important to demonstrate a transfer mechanism for large energy quantum from the lattice to the atoms and nuclei embedded in the lattice. Professor Hermann Haus has been exploring transoceanic optical communication schemes. He has demonstrated a "stretched pulse" communication technique that doubles the repeater distance as compared to existing cable. He has also designed new optical filters that are approximately 10 optical wavelengths long. These filters can be combined to produce improved response. Professor Qing Hu has observed tunable terahertz emission due to intersubband transition in quantum wells. He has also performed cryogenic pump-and-probe measurements with picosecond resolution. In addition, he has built and tested a 3x3 focal plane array using superconducting tunnel junctions. This will be useful in spectroscopy and in remote sensing for astrophysics and environmental studies.

SURFACES AND INTERFACES

Professor Simon Mochrie has developed a theory for the time evolution of grooves which self-assemble on certain stepped silicon surfaces. His theory accounts for earlier observations of how the groove width varies with the one-half power of the time after a temperature jump into the grooved phase.

CIRCUITS AND SYSTEMS

Professor Anantha Chandrakasan has devised several strategies for energy-efficient computing. These include a new technique for video compression that reduces by two orders of magnitude the number of operations performed at a low-power terminal receiving images. Professor Srinivas Devadas has developed a new computer-aided design environment and a language to describe instruction sets of vastly different processor architectures. In this way, mixed hardware-software systems can be designed to include programmable processors as well as application-specific circuitry. Professor Jacob White has formulated precorrected fast Fourier transform algorithms that can rapidly simulate complicated three-dimensional structures. These techniques computed wave-induced loads on a floating airport model, and they use three orders of magnitude less memory than traditional approaches. Professor Berthold Horn has worked on very large-scale integration machine vision systems for intelligent vehicle control and image compression for video conferencing. He introduced a new method to image the interiors of translucent objects and developed a new "time to collision" warning system, based on optical flow techniques, for use in intelligent vehicle control.

LANGUAGE, SPEECH, HEARING, AND SENSORY COMMUNICATION

SPEECH COMMUNICATION

Professor Kenneth Stevens has examined the significant variability that exists in certain consonant sounds in English in different contexts. He has explained this variability in terms of context-conditioned differences in movements of the tongue and other articulatory structures. Dr. Stefanie Shattuck-Hufnagel has been studying the intertwined effects of speech production planning, including the prosody and error patterns in spoken utterances. She conducted a major review of recent prosodic literature and has shown that the information in spoken sentences is substantially different from that in written sentences. She is also building a database that will facilitate the analysis of prosodic constraints on speech error occurrence, detection, and correction. Dr. Suzanne Boyce completed a major study of vocal tract shapes for the American English /r/ by using dimensions measured by magnetic resonance imaging within the context of a vocal tract computer model. Dr. Reiner Wilhelms-Tricarico has been building a computer program to generate a refined and accurate model of the tongue and the mouth floor by finite elements. This project will help to generate finite-element representations of other human organs.

SENSORY COMMUNICATION

Dr. Mandayam Srinivasan has developed high-resolution mechanistic models of the human fingerpad. These models confirmed earlier results, which showed that slowly adapting mechanoreceptors of the fingerpad encode the shapes of objects that indent the skin by responding to strain energy density at their spatial location.

AUDITORY PHYSIOLOGY

Professor Dennis Freeman has developed a computer microvision system that measures nanometer motions of micrometer-sized targets. In this system, a light microscope projects magnified images of a moving target onto a charge-coupled device camera. Initially, the system was used to study the motion of stereocilia in cochlear hair cells, but it has also proven useful in the study and characterization of manufactured microelectromechanical systems such as miniature gyroscopes. In order to integrate our understanding of signal processing in the ear across vertebrate species, Professor William Peake studied the structure and acoustic function of the middle ear for all species of the cat family. He measured the acoustic properties of a lion ear in a postmortem specimen obtained from a local zoo. Dr. John Rosowski studied the changes in middle-ear mechanics produced by perforations in the human tympanic membrane, such as those introduced by tympanostomy tubes that are used to alleviate middle-ear infections.

FOCUS AREAS

ATOMIC, MOLECULAR, AND OPTICAL PHYSICS

Professor Shaoul Ezekiel and Dr. Selim Shahriar have developed spectrally multiplexed holographic memories aimed at increasing the processing and storage capacities of computers. The projected capacity of such a memory is 10^{16} bits per cubic centimeter. Professor Wolfgang Ketterle has produced an output coupler for Bose-Einstein condensed atoms. This was an essential step towards the realization of an atom laser. In addition to observing interference between two Bose condensates, he demonstrated that these condensates could be released from their magnetic trap and still produce interference. This production of coherent atom beams was the achievement of a basic atom laser. The atom laser provided the first direct evidence for the coherence of Bose condensates and proved the existence of long-range correlations. Professor Daniel Kleppner has been extending our understanding of the connections between quantum mechanics and classical motion by using a new technique involving recurrent spectroscopy in a microwave field. These experiments provide evidence for one case in which quantum mechanics can describe detailed classical motion, a result that had been anticipated but not justified in theory or experiment. Professor David Pritchard demonstrated new scientific and technical applications for atom interferometers. These include the studies of fundamental physics and the measurement of atomic and molecular properties. He has shown that these atom interferometers are extremely sensitive to rotations. It is expected that an atom interferometer designed specifically for rotation sensing could perform better than the best laboratory laser gyroscope currently available.

PLASMA PHYSICS

Professor Abraham Bers and Dr. Abhay Ram continue to explore the coherent acceleration of ions in a magnetized plasma that is subjected to multiple electrostatic waves. A new nonlinear acceleration mechanism has been discovered. Among the several applications for this discovery is the possibility to slow down energetic ions, which may provide a means to extract energy from fusion-generated alpha particles. Professor Bruno Coppi has been studying a variety of plasma phenomena, and proposed the Ignitor experiment to study magnetically confined ignition. The production of an ignited plasma would be an important achievement, and would be best accomplished by using machines that operate at high magnetic field and employ cryogenic normal conducting magnets. The theory for this experiment was developed by Professor Coppi's research group.

RADIO ASTRONOMY

Professor Jacqueline Hewitt has been studying gravitational lenses. She has also been conducting searches for radio astronomical transients and for radio counterparts to gamma-ray bursts. Recent evidence of coincident events at multiple detectors is now being verified with additional detectors. In order to obtain profiles of temperature and moisture in the atmosphere, Dr. Philip Rosenkranz has modeled microwave transmittance in the atmosphere and the inversion of microwave radiometer measurements taken from satellites or aircraft. His findings have led to the construction of a microwave instrument for new high-altitude research aircraft that will provide accurate temperature and precipitation measurements.

DIGITAL SIGNAL PROCESSING

Professor Gregory Wornell has introduced new classes of error-correcting coding techniques for use in wireless communication applications. One is a novel class of analog error-correcting codes based on nonlinear dynamical and chaotic system theory that are well suited to broadcast and cellular applications. The other is a powerful class of ultralow-complexity adaptive codes for use in low-power wireless communication links. Professor Wornell has also

developed new, computationally efficient techniques to jointly exploit time, frequency, and space diversity in wireless communication systems.

ADVANCED TELEVISION AND SIGNAL PROCESSING

Professor Jae Lim continues his research on the design of a digital high-definition television system. A design specification was created by the Grand Alliance, which is a consortium of organizations, and its design was accepted by the Federal Communications Commission. Plans are now being made for the implementation of this design, and receivers will be manufactured for public sale soon.

ELECTROMAGNETICS

Professor Jin Au Kong continues his research in many areas of electromagnetic theory and applications. These include: remote sensing of the Earth and its environment, computer simulation of synthetic aperture radar returns from Earth terrain, electromagnetic interference and compatibility, microwave and millimeter-wave integrated circuits and interconnects, and simulation and analysis applied to precision aircraft landing systems.

OPTICAL COMMUNICATIONS

Professor Jeffrey Shapiro and Dr. Ngai Chuen Wong continue their research in quantum optics and radar-based automatic target recognition. They completed a study of local oscillator selection to optimize quadrature noise squeezing in homodyne detection. This study predicts a new regime of nonclassical light generation in optical fiber (Raman squeezing) and has led to a search for a comparable squeezing regime for Brillouin scattering. Professor Shapiro has also developed a wavelet-based approach for maximum likelihood estimation of laser radar range imaging.

INDIVIDUAL RESEARCH

Professor Donald Troxel continues research on distributed design and manufacture techniques. The goal in this area is to develop tools that will enable cooperative design and manufacture at multiple fabrication facilities. In one example, a personal computer at one facility remotely controls a microscope at another facility so that the results of fabrication processing can be examined at a distance.

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: (1) maintaining our high standards for recruitment procedures that include sending job postings to minority colleges and organizations; (2) 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 (3) being committed to finding new techniques to identify more effectively women and minority candidates and to being more open to suggestions in this area. During the past year, four searches were conducted, which resulted in the hiring of two female employees.

More information about the Research Laboratory of Electronics can be found on the Worldwide Web at the following URL: <http://rleweb.mit.edu/>.

Jonathan Allen

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 29 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 FY 1997 the National Office of Sea Grant awarded MIT \$3.86 million. MIT, industry partners, the Commonwealth, the Massachusetts Water Resources Authority (MWRA) and other federal and non-federal agencies provided more than \$3.2 million. In all, these funds provided partial support for 20 faculty members, nine post-doctoral and research fellows and 45 students from MIT's departments of Chemical, Civil and Environmental, Ocean, Mechanical Engineering and Earth, Atmospheric and Planetary Sciences; as well as partial support for faculty and students at UMASS/Amherst, UMASS/Boston, UMASS/Lowell, Boston College, Boston University, Harvard University, Northeastern University, Massachusetts Maritime Academy, Woods Hole Oceanographic Institution (WHOI), University of Washington and University of California.

A substantial portion of the \$3.2 million is represented by the second year portion of a five year \$11.6 million award from the Office of Naval Research (ONR). This award is intended to further the development of the Autonomous Oceanographic Sampling Network (AOSN) and will involve our Autonomous Underwater Vehicles Laboratory in collaboration with WHOI, the University of Washington and the University of California at San Diego (Scripps Institute of Oceanography)

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 area is our core research program, which reflects the ongoing MIT Sea Grant 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 two major theme areas, with quite specific concentrations: *Marine Biotechnology* and *Coastal Management and Utilization*. 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. In addition, MIT has successfully competed for and been awarded special enhancement grants in several areas.

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. Recent and ongoing research has included studies of the development of novel delivery systems for the vaccination of farmed fish (Professor Robert Langer and Dr. Yonathan Zohar, Visiting Scientist, MIT Department of Chemical Engineering), and improvements in processing underutilized fish (Professor Herbert Hultin, University of Massachusetts). Professor Don Cheney, Northeastern University, Marine Science Center, continues his research into novel and potentially important research in seaweed. Cheney is investigating seaweed as a source of compounds that have commercial potential in food processing and pharmaceuticals, *Novel Polysaccharide Production Through Seaweed Genetic Manipulation and Cell Culture Technology*. Also of commercial interest is Cheney's work on developing a strain of *nori*—a food product of high importance throughout the world—that will adapt well to the colder waters of the northwest Atlantic Ocean. This project—*Strain Improvement by Protoplast Fusion-Somatic Hybridization*—will continue into 1998.

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. There are twelve active projects in this theme area—what follows are a few we have selected to highlight. An example is a project that involved studies aimed at understanding the effects of seawalls on coastal sediment transport (Professor Ole S. Madsen, MIT Department of Civil and Environmental Engineering). This project is scheduled to be completed in July of 1997. Professor Madsen began a related research project, *Effect of Seawalls on Longshore Currents*, in March of 1997. Continuing research focused on rapid maneuvering of autonomous underwater vehicles through vorticity control (Professor Michael S. Triantafyllou, MIT Department of Ocean Engineering). Professor Joseph Montoya, Harvard University, was awarded a one-year grant “*A Preliminary Stable Isotope Tracer Study of Sewage Nitrogen Inputs to Massachusetts Bay*”, that investigated the use of stable isotope tracers to trace sewage nitrogen as distinct from marine nitrogen within the Massachusetts Bay ecosystem. Montoya followed this work with a successful proposal to continue his research with a two-year grant beginning in March 1997. A separate but related research project was also started in March by Professor Ivan Valiela of Boston University, *Denitrification and Nitrogen Attenuation in the Aquifer of an Estuarine Watershed*. This research will study the fate of organic matter as it undergoes transformation via physical, chemical and biological processes within the marine environment.

Work on underwater systems is carried out under *Coastal Management and Utilization*. Unique in its status as a research laboratory within a Sea Grant program, the MIT Sea Grant Autonomous Underwater Vehicles Laboratory is the center of much of MIT Sea Grant’s AUV research and development. Its projects are aimed at making autonomous underwater systems useful tools for coastal and open ocean research and/or engineering programs. Investigations focus on intelligent control, navigation, and the application of autonomous vehicles to specific scientific missions. This past year included a tidal front mapping study at Haro Strait, BC, using two of the Odyssey IIb AUVs. The vehicles carried water quality sensors, a side-scan sonar, and a water-current profiler. Over a 35-day period, the two vehicles performed approximately 80 dives with no significant failures. In February, 1997, the AUV Lab went to New Zealand to take part in the 3-week long “giant squid expedition.” Current efforts focus on developing the key technologies for Autonomous Ocean Sampling Networks. The MIT Sea Grant AUV Lab, sponsored by ONR, leads 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. During tests in June 1997 in Cape Cod Bay, an Odyssey AUV started 1km away from a dock. It then homed into the dock, was secured, and power was transferred into the AUV. 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, and National Geographic Society. Professor Henrik Schmidt, MIT Department of Ocean Engineering, oversees this research area as Associate Director for Research and Dr. James G. Bellingham (Principal Research Engineer) directs the AUV Lab with support from Dr. James W. Bales, Dr. Bradley A. Moran, and Mr. Robert Grieve, as well as nine Post-Doctoral Associates, Research Fellows, graduate and undergraduate students.

Our solicitation for new proposals has described a third theme area 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*” is led by Professor Michael Triantafyllou as Principal Investigator with Dr. Thomas Consi as Associate Investigator—both of the Department of Ocean Engineering. This work follows 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. The current research is focused on better visualization and analysis of the flow of fluid through which live, unrestrained fish swim. This will require 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 is 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 benefits to be gained in applying this knowledge to man-made vehicles to make better use of energy.

Focused research typically establishes a six-year set of interrelated projects initially funded exclusively by MIT Sea Grant. Projects must line up substantial co-funding from outside sources in years two through six. This past year

began with two projects still active, a third beginning last August and a fourth beginning in March of this year. The two still active projects concerned the development and application of Autonomous Underwater Vehicles (AUVs) and are both overseen by Professor Schmidt and Dr. Bellingham. *AUV: Basic Technologies* has completed its final year. *AUV: Scientific and Industrial Applications* will complete its six year research program in 1999. These last two Marine Centers have been sponsored by MIT (Vice President for Research, the Ocean Engineering Department and the Bantrell Fellowship), MIT Sea Grant, Charles Stark Draper Laboratories, ONR, NSF, the French Institute for Research and Sea Exploration, and the Department of the Navy. Additional funding sources for support of the AUV Marine Centers and/or the AUV Laboratory include Florida Atlantic University, NASA, National Undersea Research Program, RD Instruments, Lockheed Martin, and the Henry L and Grace Doherty Professorship

In August of last year a new focused research program was begun that builds upon the results of a successful Marine Center recently completed (*Coastal Water Quality*). Under Dr. E. Eric Adams, MIT Department of Civil and Environmental Engineer, who had led the prior focused research is the Principal Investigator for *Behavior of Capped Contaminated Sediments*

Our most recent focused research program is a natural outgrowth of the long-standing interest in robotics in the marine world which fueled the successful AUV program. This focused research program, *Development of Autonomous Surface Craft*, begun this past March, is led by Professor Nicholas Patrikalakis of the Department of Ocean Engineering. Dr. Tom Vaneck is managing the development and testing of the autonomous surface craft.

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 NSF, and the Department of Ocean Engineering and the MIT UROP itself raised this to a total of \$55,000. Twenty UROPs were supported this year representing six MIT departments.

Our first Sea Grant Industrial Fellow, Ocean Engineering graduate student Neil Best, has completed his first fellowship year. As part of his project, *Operational Optimization of an Ocean-Based Aquaculture Facility*, Neil spent the spring semester at Ocean Spar Technologies, the project's industrial partner, on Bainbridge Island, Washington. There he gained hands-on experience with the company's innovative systems and designed a flounder grow-out cage soon to be deployed on Long Island. This program and the experiences it brings in real-world problem solving has proven to be an excellent model for combining research and education.

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. Of particular note is the involvement of the Industrial Liaison Program (ILP) membership in Collegium activities. ILP members are invited and have been enthusiastic participants in these events.

In September of 1996 the Collegium cosponsored a two-day international conference on welding technology and research, *New Horizons in Welding Fabrication: A Conference to Honor Professor Koichi Masubuchi*, in collaboration with the Industrial Liaison Program and the American Welding Society. Speakers and participants from East Asia, Europe, South America, and industrial and academic representatives from North America provided a comprehensive review of materials, methods and applications. In addition to serving the primary purpose of the Marine Industry Collegium this conference honored Professor Koichi Masubuchi of the Department of Ocean Engineering for his outstanding contributions to the science of welding and for his many successes in developing experts in this field, many of whom were present at the conference.

A second aquaculture event was held later in the year (November 11), *Longline Shellfishing and Aquaculture Workshop*, that continued to highlight the commercial opportunities and challenges of aquaculture in the Northeast.

This event, was structured around case studies of successful shellfish farming activities in the Canadian Maritimes, and in Australia and New Zealand. Reviews of engineering issues and legal/permitting considerations provided proper perspective for the broad set of interests represented in the audience.

MIT Sea Grant's engineering focus in marine fisheries continues with the Center for Fisheries Engineering Research (CFER). This project was initiated in 1982 and today continues to have a national impact by applying analysis and model-testing techniques to the hardware-related problems associated with marine living resource utilization. The project has assisted industry in the development of resource-sparing and selective trawl nets.

Since its establishment in 1982, CFER project director Cliff Goudey has varied the emphasis depending on the needs of the fisheries. 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

Notable efforts include a project to develop techniques for improving sea scallop productivity through controlled harvesting of seeded beds and through off-bottom culture in open waters. This project has led to the establishment of the first experimental aquaculture research area in the US federal waters. In another project, CFER organized an experimental fishery to evaluate pair trawling for tuna and its effects on marine mammals.

Recently CFER established Aqualab, a demonstration site for urban aquaculture at the Charlestown Navy Yard. This is the first step in exploring the potential for an aquaculture industry in Boston Harbor. Collaborations with the City of Boston have led to a plan to convert Moon Island into a major center for commercial aquaculture.

The Massachusetts Marine Liaison Service (MMLS) works 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 continued to track the social impact of new fisheries regulations and has planned focus groups for Gloucester and New Bedford to assess their effects. Hall-Arber is President-elect of the American Fisheries Society's Subcommittee on Socio-economics and a member of the Atlantic States Marine Fisheries Commission's Committee on Economics and Social Sciences. In addition to these posts, Hall Arber serves on the advisory board of the Massachusetts Coastal Zone Management Program, is a member of the New England Marine Advisory Council, and is president of the Women's Fisheries Network. Public education efforts continue through exhibits, participation in conferences and festivals and articles in Commercial Fisheries News.

The Sea Grant Communications/Information Service under the leadership of Andrea Cohen produces outreach materials for a wide variety of consumers. In addition to our ongoing activities, notable achievements from the last year have included a new joint publication produced 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. The department is also significantly involved in a major exhibit at the New England Aquarium. C. Levi of our communications staff played a role in its initial conceptualization and continues to participate in its development. Called "Sounds in the Sea", its purpose is to educate the public about the nature of sound in the oceans. In the past year, Communications also collaborated with the Metropolitan District Commission and Friends of Magazine Beach, a community group, in sponsoring the Second Annual Clean-Up of Magazine Beach and the Banks of the Charles. Communications continues to write for the Nor'easter magazine (circ. 12,000), along with other Sea Grant programs in the Northeast region

From July 1996 to June 1997, the Communications office filled over one thousand requests for publications. This distribution included schools, businesses, government, citizens, media, the MIT community and others

The newest addition to MIT Sea Grant, the Center for Coastal Resources, brings science and technology research to state and federal agencies' staff, local government officials and other entities. The Center helps improve decision making in management of coastal resources and strengthens policy development. The Center for Coastal Resources has continued to provide outreach activities that bring scientists, coastal resource managers and users together. This past year has seen the completion of the third mini-course focusing on metal contamination in coastal areas, collaboration in convening several conferences and workshops, and continuing efforts for coordinating regional research and management of the Gulf of Maine. The mini-course was on *Metals in Aquatic Ecosystems* that serves as continuing education for practicing coastal managers, public advocates for environmental issues, scientists and

students. Judith Pederson, Manager of the Center for Coastal Resources co-convened a workshop supported by the North Atlantic Commission for Environmental Cooperation on *Sustaining Resources in the Gulf of Maine: Toward Regional Management Actions* and co-authored a white paper for that conference. She co-convened a conference on the *Effects of Fishing Gear on the Sea Floor of New England* and served on the Steering Committee of two workshops focused on research and management in the Gulf of Maine. A Mass Bay web page has been developed to provide linkage to data and research, and other information for the Massachusetts and Cape Cod Bays and Boston Harbor regions. Follow up activities include communicating workshop and conference outcomes to coastal managers and have resulted in guidance and policy documents relating to appropriate use of introduced species in aquaculture.

These courses featured researchers from MIT, the Woods Hole Oceanographic Institution, the University of Massachusetts and other academic institutions, attracting scientists, students and those involved in managing coastal resources from all New England states. Other activities include sponsoring or co-sponsoring workshops where Sea Grant -funded researchers and others presented findings regarding introduced species, factors in groundfisheries decline, and the impacts of contaminants on marine organisms.

The joint educational program established with the Massachusetts Maritime Academy (MMA) twenty years ago has grown in terms of the educational/training needs it addresses and in its participation. During the past year MMA has instituted a series of seminars oriented towards aquaculture and fisheries issues—these are natural extensions to their traditional constituency of recreational and commercial users of coastal waters.

MMA's annual Saltwater Fishing Seminar is now in its 18th year and continues to draw approximately 100 participants every year. Shellfish Farming Forum and Aquaculture Symposium events held this past winter drew considerable interest. Most 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.

During the past year, the New England Science Center was funded to develop an electronic atlas using an accessible Geographic Information System and data from Boston Harbor for use by teachers in grades 5-12. A 6-week training program introduced teachers to the World Wide Web, provided hands-on opportunities for them to become familiar with the information and encouraged them to identify ways to use the materials in their science curricula.

PROGRAM MANAGEMENT

The program director is Chryssostomos Chryssostomidis, professor in the Department of 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.

MIT Sea Grant administers the Doherty Professorship endowed by the Henry L. and Grace Doherty Foundation. In 1997 Professor John Leonard of the Department of Ocean Engineering, was awarded the two-year chair for his proposal, "*Dynamic Underwater Sonar Data Fusion*". Dr. Leonard will investigate the unique ability of certain animals—dolphins in particular—to combine controlled movement of the animal with their sonar capability to interpret size and shape of objects of interest. Extensive use of the experimental facilities within the Institute will permit Professor Leonard to involve students in his research—an important aspect of the Doherty Professorship and one that continues to nourish the intellectual process so vital to a university community.

Paul E. Laibinis, an Assistant Professor of Chemical Engineering continues in his second year of his Doherty Professorship. Professor Laibinis' research concerns the preparation of organic barrier films that impede metal corrosion in aqueous and saline environments.

More information about the Sea Grant College Program can be found on the World Wide Web at the following URL: <http://web.mit.edu/seagrant/www/>.

Chryssostomos Chryssostomidis

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 science and technology in the socioeconomic growth of developing countries. 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

The past year saw the continuation of three multi-year collaborative programs. Work with the Government of Mendoza to provide research, education, and administrative assistance to the newly created Fundación Centro de Innovación Tecnológica (CIT) Mendoza continued and the research effort remained focused on (a) Regional Planning for Intermodal Transportation in Mendoza; (b) Internationalization and Competitiveness: the Case of the Mendoza Region of Argentina; and (c) Multi-Attribute Evaluation of Water and Energy Resources in Mendoza.

The following research activities are being undertaken under the Collaborative Program of Science and Technology between MIT and the National Science Technology and Development Agency of Thailand (NSTDA) and the Collaborative Program of Science and Technology between MIT and the King Mongkut Institute of Technology, Thonburi (KMUTT). “Analysis of Relative Production Costs in Thailand and Other Countries (Professor Joel Clark); “Analysis of Adjustment to International Opening; Comparison of Thailand, Taiwan, and Mexico (Professor Alice Amsden); Design Studio: The Case of KMUTT Rajaburi Campus, Thailand (Professor Michael Dennis); and Chemical Engineering Practice School in Thailand (Professor Alan Hatton); Establishment of TGIST (Thailand Graduate Institute for Science and Technology (Professor Fred Moavenzadeh). In addition research is being explored in the following areas: Morphology Control in Immiscible Polymer Blends Through Interfacial Reaction and Rheology (Professor Chris Scott); Regional Strategic Transportation Plan for Thailand (Professor Joseph Sussman); Multi-Media Technology (Professor Steven Lerman); and Shrimp Biotechnology (Professors Daniel Wang and Charles Cooney). In addition Professor David Marks has proposed a project entitled “Water Resource Management Activities in Thailand, Research, Technology Transfer, Education and Human Resource Development”; and Professor Daniel Roos has proposed several activities under IMVP. The organizational and administrative structure for KMUTT Rajaburi is being assisted by Mr. Robert Greene.

On January 14, 1997 TDP signed a multi-year Agreement with the Malaysia University of Science and Technology Ehsan Foundation (MUST) to Support the Establishment of the Malaysia University of Science and Technology. The focus of this program is on academic programs, research program, institutional building, and industrial and governmental collaboration and linkages. Professors Michael Dennis, Jean DeMonchoux and Mr. Ovida R. Simha are assisting MUST with the Physical Master Plan for MUST. Mr. Robert Greene is leading a team in the organizational and administrative structure for MUST. Research efforts are being pursued in the following areas: (a) infrastructure, (b) information technology/multi-media; (c) Biotechnology and Chemical Engineering; (d) Advanced Materials; (e) Manufacturing; and (f) Energy and Environment.

In addition to the above research efforts, TDP continued its association with the Consortium on Construction and Global Environment. Since 1990 TDP has been working with three major construction companies in Japan; namely,

Hazama Corporation, Nishimatsu Construction Co., Ltd. and Sato Kogyo Co., Ltd. in helping to identify key areas and issues of global environmental change which will create future opportunities for the world's leading engineering and construction firms; and to suggest effective strategies for capitalizing on these opportunities. The primary focus of this year's activities has been on municipal solid waste landfill sites and in particular information on: (a) improvement of performance (such as lining systems, leakage detection systems, leakage repair systems, etc.), (b) longer life sites or extension of life of use (compression of volume of landfill waste, repairing or upgrading of existing landfill sites, landfill mining, etc.) and (c) uses of waste filled sites after closure of the facilities.

FUTURE RESEARCH INITIATIVES

The Technology and Development Program has submitted proposal for Collaborative Agreements in Brazil and is also pursuing activities in Taiwan, Korea, and Colombia.

In Brazil the collaborative effort would be between TDP at MIT and USP, UNESP AND UNICAMP in Brazil. The research would be conducted for a seven (7) year period for a total cost of \$42 Million, with funding for the first two years at \$10 Million. The Collaborative Program would support the establishment of a Center for Technological Innovation in San Paolo Brazil and would include activities in the following areas: (a) research projects, (b) educational (exchange of students and visitors), (c) curriculum development; (d) short courses, executive seminars and workshops; and (e) industrial linkages/outreach program.

CURRENT EDUCATION INITIATIVES

The TDP-sponsored Middle East Program at MIT completed its tenth 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.

Short courses in Construction Engineering and Management; Process-Engineering and Fermentation Technology; Recovery of Biological Materials; and Transportation and Logistics were offered in Thailand this past year.

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, George Macomber Professor of Construction Management in the Department of Civil and Environmental Engineering. Professor Nazli Choucri of the Department of Political Science is the Program's Associate Director and Patricia Vargas is the Executive Officer.

Fred Moavenzadeh

LIBRARIES

The MIT Libraries provide relevant, high-quality information resources and services in support of the educational and research activities of MIT. The Libraries have fulfilled this mission with distinction for many years, acquiring materials and delivering services essential to MIT's dynamic community. Today, as MIT and its Libraries confront the emerging impact of information technology on higher education, the Libraries' challenge is to devise transitional service strategies, and to be prepared to adapt and evolve their traditional functions. The year 1996/1997 was a time during which the MIT Libraries renewed their focus on the central purposes of the Libraries, and began the critical process of rethinking the research library for MIT.

Major challenges confront academic research libraries, and the MIT Libraries are no exception. Fundamental changes in the ways scholars communicate among themselves present opportunity (for faster, cheaper communication) and risk (for loss of authenticity and permanence). Unremitting double-digit inflation in the serials base continues, even as the volume of growth in published content for the disciplines supported at MIT places relentless pressure on collections and space. The high cost of scholarly electronic publications, the changing nature of the skills required to use and work in libraries, and the expectations of the MIT community are, likewise, important concerns for MIT's Libraries.

Scores of scholarly disciplines and sub-disciplines are supported by the MIT Libraries, each with its own print and electronic publications. Required resources range from the popular to the esoteric, and must address the needs of a community that itself ranges from undergraduate students to tenured faculty. Through it all, the MIT Libraries have an obligation to assure the availability of important works over time; so that in the 21st Century, MIT students and researchers will have the same ability to draw upon a coherent body of knowledge as do the students and researchers of today.

A TIME FOR NEW INITIATIVES

During 1996/1997, the MIT Libraries gave serious attention to testing the operational requirements and viability of the Digital Library. While a relatively small percentage of scholarly publishing has an electronic equivalent at present, the scene is changing steadily. Recognizing the need to more fully explore the Digital Library, Library Council established three specific initiatives that would facilitate access to electronic information resources. Leadership for these strategic initiatives came from within Library Council, with major support from individuals and groups across the Libraries staff.

Networked information resources. The MIT community is at work all hours of the day and night. To "open" the MIT Libraries beyond existing hours and locations, the Libraries launched a program to significantly increase the provision of scholarly information resources over MIT's network. Web-based products were selected, principally because of network requirements and the ubiquity of web browsers. In consultation with faculty, eighteen important electronic databases were selected and acquired; satisfying long-standing needs of both faculty and students. Simultaneously, pre-existing license agreements for the most heavily used commercial database vendors were extended to include additional sites.

Automated authorities control. When the MIT Libraries' catalog of library holdings became available on the network, patrons could search for items from anywhere on campus. To improve the quality and usability of the Barton database for remote users, the Libraries initiated automated authorities control. This initiative creates cross references within the catalog, and increases the accuracy and completeness of search results. Once the initial quality improvement is completed, the Libraries' catalog of holdings will be enhanced on a quarterly basis.

Computer support within the Libraries. Desktop computing, networked information resources, and web-based educational and research tools have become a reality in the MIT Libraries within a very short period of time. All areas of the Libraries now require a level of computer support that cannot be sustained with traditional organizational models. At the same time, the specific skills required to perform ordinary library functions in the contemporary library are evolving. This initiative segments the tasks required within a contemporary library, provides for adaptive training, establishes point positions for key areas of responsibility, and creates a new model for communication and support within the computer-based activities of the MIT Libraries.

A TIME FOR FUNDAMENTALS

Even as the MIT Libraries explored the digital environment, the inexorable demands of traditional print continued. Because print still provides the vast majority of material used by MIT students, researchers, and faculty, activities within the MIT Libraries also focused on the four fundamental aspects of an effective research library: services, staff, information resources, and facilities.

Services

The MIT Libraries undertook several studies and surveys to gather data about the current use of the Libraries collections and services. One survey, which included every public service unit of the MIT Libraries, captured information regarding patron status, the purpose of the visit, and the level of success/satisfaction experienced in the visit. Simultaneously, traffic volume into the Libraries web server was captured to compare in-library volume to network access volume. Other surveys collected data on activities such as reference type and volume, and walk-in traffic.

In a fourth strategic initiative, Library Council addressed the Libraries' emerging need to deliver consolidated fee-based services. Two important service issues are addressed through this initiative. First, as the MIT Libraries renew their focus on the MIT community, they must also acknowledge the importance of the MIT Libraries to the community outside the Institute. MIT's collections are exceptionally strong in many areas, and access is highly valued by scholars and researchers beyond MIT. Second, as the MIT Libraries develop strategies for sustaining service with available resources, tiered or premium services may become appropriate. This Library Council initiative explores the implications of offering tiered services to the MIT community, and provides tools for the Libraries to better manage the demands of non-affiliated patrons.

The Engineering and Science Libraries accepted the challenge of designing a new approach to meeting the information needs of the Physics Department. Subscriptions to 42 electronic physics journals, and a variety of other electronic resources, were made available to the Physics Department through a customized Physics and Astrophysics web site: <http://libraries.mit.edu/science/Subjects/physics.html>.

Reference librarians from across the MIT Libraries built an online, web-based collection of reference materials for the MIT community. The Virtual Reference Collection can be accessed at: <http://libraries.mit.edu/services/virtualref.html>.

The Humanities Library conducted a test of the feasibility of providing web-accessible scanned images of required reading, as an alternative to the print versions in the Reserve Book Room. In collaboration with faculty, Document Services, and the Library Systems Office, a highly successful image-based network-accessible "reserve reading room" was created.

Staff

During 1996/1997, the Libraries began to address the changing nature of library work and the associated training requirements. In a distributed system such as the MIT Libraries, the professional and administrative staff of the Libraries carry significant responsibility for shaping the future of the Libraries' resources and services. The Libraries Steering Committee determined that these staff should receive an improved level of support and attention to reflect the changing nature of Libraries work. Training programs were developed and delivered to enable staff to work effectively in new ways, and to better understand the nature of and responses to change. Recognizing the need for an improved focus on administrative and professional staff, a Director's Office position was restructured to provide targeted administrative support for professional and administrative personnel issues within the Libraries.

Library Council also addressed staff issues through the establishment of a fifth strategic initiative: to market library expertise to the MIT community. The professional expertise resident in the staff of the MIT Libraries represents a unique capability within the Institute. No other MIT department possesses the combined insights and knowledge of published sources, scholarly research behavior, bibliographic instruction, and digital information resources. When this expertise is deployed effectively, particularly when working with faculty, students and faculty alike gain great benefit. This initiative developed strategies and tools for integrating information literacy into courses, and for identifying and reaching out to interested faculty.

The year was also remarkable in the demands it placed on the MIT Libraries staff. No report would be complete without special recognition of the exceptional contributions of so many Libraries staff. Every department faced a major challenge of some kind, and yet the Libraries' accomplishments during 1996/1997 were extraordinary. The enthusiasm and energy of the staff are a tribute to their individual and collective commitment to MIT and the MIT Libraries. Special thanks go to Margaret de Popolo for accepting leadership, mid-year, of the Institute Archives and Special Collections, and to Theresa Tobin, Ruth Seidman, and Margaret de Popolo for energetically advancing the Public Service agenda in the absence of an Associate Director.

In 1996/1997 the MIT Libraries said farewell to two individuals whose keen intellects and years of service profoundly influenced the MIT Libraries. David Ferriero, Associate Director for Public Services, resigned in July to accept leadership of the Duke University Libraries. In April, Helen Samuels, Institute Archivist and Head of Special Collections, accepted a policy position in the Office of the Associate Provost in order to more actively pursue her research interests in the archiving of electronic records. The MIT Libraries will long remember their many contributions.

In 1996/1997 the Libraries also celebrated a new beginning, with the appointments of Virginia Steel as Associate Director for Public Services, and Eric Celeste as Assistant Director for Technology Planning and Administration. Steel and Celeste were named to their positions following extensive national searches. The Libraries are indebted to the Information Systems Department for their advice and participation in the successful conclusion of the Assistant Director position.

Information Resources

During 1996/1997, the Libraries' achieved remarkable improvements in the usability of and access to information resources acquired by the Libraries. In addition to the Digital Library activities described above, Collections Services made great strides in both work process improvement and retrospective conversion rates. Major progress was made toward a viable plan to address the large (and largely invisible) Dewey Decimal Collection.

Institute Archives launched a project to document the history of Building 20. In anticipation of the evacuation and demolition of this venerable edifice, special funding allowed Archives staff to assist departments and individuals located in Building 20 with the disposition of their records. Project Archivists also conducted a photographic documentation project, gathered historical facts about Building 20, and developed a presentation on the history of the building.

The Library Systems Office oversaw the complete redesign of the MIT Libraries' Home Page. Utilizing the talents of a consulting team, both the graphical design and the underlying structure of the Libraries web site were redesigned. The goals of the project were to improve the site's appearance, increase the ease with which new material could be added, and ultimately reduce the overall maintenance effort.

Facilities

In 1996/1997, considerable progress was made to improve the quality and appearance of a number of Libraries' spaces. With some notable exceptions, the Libraries public spaces have not kept pace with changing service requirements. Adequate, quiet, and comfortable seating; space and infrastructure needs of digital library resources; a contemporary mix of study spaces; and sufficient shelving capacity for print resources are among the service requirements in need of attention. With generous support from the Provost, former and current Associate Provosts for the Arts, Physical Plant, and many friends of the MIT Libraries, the Libraries began to address some deferred facilities needs in 1996/1997.

The new Rosalind Denny Lewis Music Library is a splendid tribute to music scholarship at MIT. This highly successful renovation was made possible through the generosity of friends and alumni of MIT, and was celebrated with a dedication and open house in December. Other, smaller projects included office remodeling in Archives, upgrading the chairs and carpeting in the Humanities Library, and designing and installing a new reference desk and LAN workstation counter and chairs in the Science Library. Planning for a redesigned and consolidated service desk in Dewey Library culminated in a June construction start.

OTHER ACTIVITIES OF NOTE

In April 1997 the Libraries' Visiting Committee convened in Cambridge. The theme of the meeting was "Libraries in Transition". The Committee's visit provided an opportunity for the Libraries to review their many accomplishments during the two years since the Committee's last visit, and to garner insights and ideas from the members of the Committee. Presentations by senior staff informed (and entertained) the committee, as did the hands-on demonstrations of new services and resources; made possible by staff from many service departments within the Libraries.

Progress was made toward operating more effectively in the Libraries new local system, Geac Advance. While significant difficulties persist, particularly in Circulation and Reserves functionality, considerable gains were made in online journal check-in, in report writing, and in cataloging efficiencies. The Libraries continued to meet and correspond with Geac, Inc., in a systematic approach to addressing outstanding issues.

The Libraries continued to pursue opportunities to collaborate with other high-quality libraries. Cooperative agreements provided significant discounts for electronic resources and enabled the Libraries to leverage MIT's financial resources. Existing agreements with the Boston Library Consortium, North East Research Libraries, and Harvard University continued, and new arrangements with JSTOR and the Harvard-MIT Data Center were negotiated.

A sixth Library Council strategic initiative, to improve and support Libraries development activities, was launched with support from the Vice President for Resource Development. The MIT Libraries house one of the world's finest collections of scientific and technical materials. Deep strengths exist, additionally, in the collections that support management, architecture, planning, and key areas in the social sciences and humanities. Because these disciplines produce many of the most expensive publications available today, the costs of maintaining such world-class resources, in the many media required, have outstripped the Libraries' ability to pay. New financial resources are urgently needed to stabilize and sustain the Libraries print and electronic collections until larger, external economic issues can be resolved. This initiative is the first step in a journey of many miles, intended to acknowledge the importance of the Libraries' many generous alumni and friends, and to strengthen the Libraries finances through resource development.

The individual reports that follow this overview provide additional detail on the activities of the MIT Libraries during 1996/1997.

Ann J. Wolpert

PUBLIC SERVICES

This year was marked by a major reorientation in the MIT Libraries approach to providing digital resources to the community. During 1996/1997, online databases and full-text database services were selected and installed for direct use by the Libraries' patrons -- both over the campus network and in any MIT Library. While librarians are still available to conduct complex searches for those members of the MIT community who prefer the precision of a skilled searcher, do-it-yourself searching is now widely available on campus. This reorientation was accomplished through three concentrated efforts.

- Increasing web-based resources through a Library Council Initiative. In recognition of the system-wide impact of distributed digital resources, a group was formed to address the changes that would be required. Collection Managers and Reference Coordinators joined with the Libraries Collection Management Group to create a task force dedicated to Networked End-users Resource Development (NERD). The task force not only implemented a large array of new databases, but also created a process to continue development in this area. Some of the significant new databases include: Compendex, Biosis, Geobase, Transport, Linguistics and Language Behavior Abstracts, three IAC Insite databases (Business, Computer and Market Information), and Anthropological Literature Index.
- Increasing access to the news, full-text, and indexing resources licensed by the MIT Libraries. Lexis-Nexis, Dow Jones (Dow Jones News Retrieval), and Dialog Business Connection are now available through four

libraries: Dewey, Science, Rotch, and Barker Engineering. New license agreements were signed to provide access to Firstcall and Datastream.

- Increasing the diversity of the CD-ROM databases running on Local Area Networks within individual libraries. There are now over 75 major resources mounted in the libraries. In addition to these resources, many hundreds of government documents are available to use in a library, or borrow.

Reorienting digital resources toward a model of network-based self-service created a number of opportunities to enhance other traditional library services. Notable among these efforts were the development of a Virtual Reference Collection, a new approach to Information Instruction, and an experiment which delivered reserve materials to students, electronically.

The Virtual Reference Collection is a web-based service that brings together on one page a wide array of pre-selected sources of frequently used information. Included in the Collection are digital dictionaries, directories, encyclopedias, manuals, maps, and a wealth of other useful general and technical electronic information sources. The Collection builds upon the subject-specific web pages that are maintained by the staff of our public service units to support the academic disciplines of MIT. The Collection's links point to free sites as well as resources to which the MIT Libraries subscribe on behalf of the MIT community. The Libraries' reference coordinators developed the Virtual Reference Collection page, which is now maintained by the Associate Head for Information Services of the Dewey and Humanities Libraries.

Information Instruction in the networked digital environment presents new opportunities and challenges. The MIT Libraries response came in the form of (1) increased training and instruction for the MIT community and (2) expanded but structured opportunities for one-on-one research consultation and advanced-level training. Training in the use of the most popular online databases was offered frequently throughout the year. Support for undergraduate education in core information competencies was a high priority in 1996/1997, with an emphasis on working with faculty on course-based training. Libraries-wide support to Course 9 (Introduction to Psychology, 9.00) and Course 2 (Design Project, 2.73) were among the most intensive and successful efforts.

Another foray into electronic resources was lead by the Humanities Library, in conjunction with Document Services and the Library Systems Office. With the enthusiastic support of an Anthropology Section faculty member, an experiment to electronically deliver reserve materials to students was conducted. The experiment was so successful that in 1997/1998, the MIT Libraries will work with MIT's Information Systems Department to develop processes that can scale up to serve the larger MIT community.

In counterpoint to these many digital developments, the newly renovated Rosalind Denny Lewis Music Library opened to rave reviews in October. In an architectural tour de force, the former Music Library was transformed into a two-level jewel for the study and research of music at MIT. Renamed in honor of Rosalind Denny Lewis, the Library was dedicated, and the library's principal donors and many friends sincerely thanked, in a well-attended celebration in early December.

During 1996/1997, the Public Services units of the MIT Libraries undertook a variety of surveys and studies designed to gather information on the Libraries user community. The most significant survey was an exit survey, conducted in every public service unit. The survey identified users by category (undergraduate, graduate, non-MIT, etc.), captured the purpose of their visit, and measured the level of success/satisfaction with library services. The highest users of the Libraries are MIT students (graduate and undergraduate) and MIT researchers. Study and research are the two most prevalent uses. As suspected, other academic communities and the general public place considerable demands on our collections and services. Data from the survey informed ongoing projects to review the outside users policy and expand fee-based services.

An important, but more narrow, survey was conducted to analyze the information needs of the Physics Department. Following faculty and graduate student interviews, and after a benchmark study of library support for Physics Departments in 10 peer institutions, the Engineering and Science Libraries developed a new approach to providing information support to Physics at MIT. The approach has three elements: (1) the development and maintenance of a high quality web page focused exclusively on the information needs of Physics and Astrophysics, (2) subscriptions

to over 40 physics journals in electronic form, and (3) collaboration with the Physics Department on a transition strategy for the print-oriented Physics Reading Room.

Institute Archives and Special Collections undertook a special project to assist departments and individuals in Building 20 with the appropriate disposition of their records and files. Anticipating the demolition of this historically significant building, project archivists worked systematically with all administrative offices, individuals, and clubs resident in the building. Excellent progress has been made in this delicate and challenging assignment to gather and process records before occupants were moved from the building. The archivists also conducted a photographic documentation project, funded by Physical Plant, to record the structure in its final years of service. Building 20's history also became a focus of fact-gathering over the year; culminating in a presentation to the MIT System Design and Management Program.

During 1996/1997, Document Services made significant progress toward its goal of financial self-sufficiency. Operating improvements were realized in both cost savings and revenue enhancements. Document Services eliminated nonproductive programs, aligned staff size with demand, and introduced new, useful services. Over the course of the year, interlibrary lending services (including BookPage) were transferred to the department, and plans were developed to transfer privilege card sales to Document Services in 1997/1998.

Staff training, professional development, and support for staff-conducted library and information science research continued to be a high priority for the Libraries Public Service units. Public Service librarians participated in intensive presentation skills training, and in HTML and web design training. Opportunities were provided to attend introductory and specialized library management training. Support (financial and flexible time) was offered for travel to important conferences, and for the conduct of professional research.

The MIT Libraries continued to pursue opportunities to collaborate with peer libraries in New England and across the United States. The Boston Library Consortium, and the North East Research Libraries, provided opportunities to leverage the Libraries purchasing power and to provide a rapid response when needed information resources are not available at MIT. The MIT Libraries cooperative agreements with the libraries of Harvard University provided local access to research material not owned by MIT, and opened the door to additional successful collaborations; such as the Harvard-MIT Data Center agreement, and joint staff development programs with the Harvard College Libraries.

Margaret dePopolo, Ruth Seidman, Theresa Tobin

COLLECTION SERVICES

During 1996/1997, Collection Services made major steps forward in incorporating digital information resources into its services and processes, in improving its major user product -- the online catalog, and in realizing the benefits of automation to improve the efficiency and effectiveness of its work.

INCREASING ACCESS TO INFORMATION RESOURCES

For several years the Libraries have been slowly adding digital resources to the traditional collection of print resources we acquire for the MIT community. The first major thrust was the acquisition of CD-Rom databases in the late 1980's, which we made available initially on single stations within the libraries, and more recently on local area networks within individual libraries. In the mid-1990's, a few significant networked products were added: Britannica Online, Oxford English Dictionary, and several electronic journals. At the beginning of 1996/97, the growth of the World Wide Web and the availability of effective network navigation software had created a much more fertile environment for distribution of digital resources, and the Libraries' staff decided to utilize a project approach to learn how to manage our traditional business of acquiring information resources in this new environment.

The project became one of the Libraries' strategic initiatives: to significantly increase the provision of scholarly information resources on the MIT network. A small project budget was established and staff began to work through the processes and develop the expertise required to acquire networked access to information resources. While the selection decisions for print products are based almost exclusively on content and price, digital products introduce several other areas for consideration: effectiveness of search interface, competitive offers from various providers,

license terms, and technical requirements. In order to manage these more complex decisions, the Libraries created a working group of collections managers and reference coordinators -- Networked Electronic Resources Domain (NERD), defined a role of product sponsor for subject specialists, and created one new position: Assistant Acquisitions Librarian for Digital Resources. An important result of the year's project is that many MIT librarians have moved up a steep learning curve. We are much more able now to assess interfaces, to evaluate pricing proposals, to understand and negotiate license terms, and to understand the relationships between various providers' packages of products. The most obvious and significant result for the Libraries' users is the actual list (see below) of new products now accessible on the MIT network. The products span the disciplines reflected in MIT education and research. Some are significant bibliographic databases; others are full-text. Some are current publications; others are retrospective. Together they represent an impressive transition toward providing core scholarly resources to MIT scholars and researchers in the office, lab, and dorm room. We are planning a publicity program to inform returning students and faculty about these new networked resources this fall.

Anthropological Literature: index to journals in anthropology and related subjects. 1984-present

Bibliography Of The History Of Art: index to journals in art and art history. 1973-present

BIOSIS Previews (combines BIOSIS and "Reports, Reviews, and Meetings"): abstracts of articles, reviews, and books in the life sciences. 1990-present

Business Insite: full-text or summaries of articles from business periodicals. Latest four years

Computer Insite: full text or summaries of articles from computer periodicals. Latest four years

GeoBase: abstracts from journals in physical and human geography, geology, mineralogy, and development studies. 1980-present

GeoRef: abstracts from journals, books, reports and maps in geology and geosciences. 1785-present

Hispanic American Periodicals Index: index for journals on U.S.-Hispanic and Latin American topics. 1970-present

JSTOR: an archive of back volumes, in full-text, for major scholarly journals. New subjects and titles are added continuously. Back volumes cover from Vol.1 of each title to recent years. The latest volume archived depends on each publisher's archiving decision, but is generally within 3 to 5 years of the present year.

Linguistics & Language Behavior Abstracts: abstracts from journals, books, and dissertations in linguistics and related subjects. 1973-present

Market Insite: full text or summaries from market information publications. Latest four years

Materials Science databases: *Engineering Materials Abstracts* 1986-present; *Materials Business File* 1985-present; *METADEx* 1966-present Abstracts, news, and reports covering industry, regulations, applications and technical information on metals, alloys and non-metallic materials.

Meteorological & Geostrophysical Abstracts: abstracts in the fields of meteorology, climatology, oceanography and related subjects. 1974-present

Project MUSE: full-text of the journals published by the Johns Hopkins University Press. 1997, with earlier years for some titles

Transport: combines three indexes: *International Road Research Documentation*, *TRANSDOC*, and *Transportation Research Information Service*. 1968-present

World News Connection: a foreign news alert service containing summaries from print and broadcast media on socioeconomic, technical, political and environmental topics. Latest two years

There was also significant progress this year in improved management of collection development of print resources. Under the direction of the Collection Management Group, subject specialists produced draft collection development policy statements for over half of our subject areas. This work will be completed in the next year. In addition, the goal of spending the collections budget at a 100 percent level was aggressively and successfully pursued.

IMPROVING THE LIBRARIES' ON-LINE CATALOG DATABASE

Another major focus for Collection Services this year was a second Libraries' strategic initiative: implementation of automated authority control. The results of this initiative will also benefit students, faculty, and researchers this fall. During the spring and summer months, the Libraries had its database of 758,000 online catalog records processed by an outside vendor for the purpose of bringing greater consistency to the name and subject headings and providing cross references from alternate forms of names and subjects to the authorized forms used in the catalog. This project required careful planning on the part of several key staff members to select a vendor, to manage requisite systems upgrades, and to determine the logistics of electronically transferring the database to the vendor and subsequently reloading and re-indexing it without unduly disturbing the use of the database by library patrons or staff. The result will be significant improvement in the ability to successfully search the database for known items, and to bring together all items by or about a given author or on a given subject.

Another noteworthy improvement in the Libraries' online catalog was the addition of records for the Libraries' collection of sound recordings. The catalog now provides complete, integrated access to all cataloged music scores, books, and sound recordings. This enabled the newly renovated Music Library to open its doors without space allocated for card cabinets. In addition, significant progress was made in adding records to the catalog for the Libraries' retrospective collections of serials and theses.

PLANNING FOR CATALOGING DIGITAL RESOURCES

The addition of digital resources to the libraries' offerings raises important issues related to the building and maintenance of the Libraries' catalog. The bibliographic records that make up the catalog are prepared in conformity with national cataloging standards which enable libraries nationwide to cost-effectively cooperate in the creation and use of catalog records. The standards have developed over decades and reflect responses to the broad scope of user needs and publishing practices. Digital publishing has not yet developed the standards that print publishing has, and user needs in relation to these new products are not nearly as well understood. The library profession is in the beginning stages of developing the standards necessary for useful bibliographic records for these items. This year in the Electronic Resources Cataloging Task Force (ERESCat), Collection Services staff defined local practices for cataloging these materials, and, through participation in two national cooperative projects, CONSER and InterCat, contributed to the development of national standards. In the second phase of the work, the Libraries' catalogers are currently initiating a project to catalog digital networked resources. This work will prepare our catalog for another transition expected within the next year: a WWW format for the catalog. When that is implemented, the catalog records we are beginning to create will make it possible to link directly from the catalog record to the digital resource via the URL, a significant advance in information retrieval.

REAPING THE BENEFITS OF AUTOMATED PROCESSING

This year several advances in the use of technology came together to considerably improve the efficiency with which we can provide bibliographic and physical access to new materials. In keeping with the Libraries' strategic initiative to reorganize computer support, Collections Services has designated and currently posted an Information Technology Librarian position, and each of the three departments has designated half of an existing position as a Local Technology Expert. The staff in these new positions will provide enhanced technical expertise and skills development within Collection Services.

Already this year, productivity benefited greatly from expanded use of technology. The production of spine labels in Binding and Repair was automated, saving staff time and ensuring accuracy. The installation of OCLC's Passport for Windows software on all catalogers' desktops accelerated the use of staff-created macros to perform automated shelflisting, to automatically review cataloging copy for level of difficulty, and generally to streamline procedures. Macros are now also used in acquisitions to facilitate receipts processes, reports production, searching and fund

information displays . The benefits of automated check-in of government documents and serials continue to accrue. Serials check in staff fine-tuned processes in the first full year of automated serials control and began to use the systematic claiming features. Tangible evidence of our progress in automating procedures was the removal of kardex and shelvest card cabinets from our working areas this year!

IMPROVED PRODUCTIVITY

The most measurable advance this year was the improvement by approximately one-third in cataloging productivity in both serials and monograph cataloging units. This is a level of increase rarely achieved in one year in any technical services work. While the use of technology was essential to this achievement, equally essential was the hard work and continuing commitment of staff. Indeed the technical gains themselves would not have been possible without staff "savvy", with which the MIT Libraries and Collection Services are truly blessed.

Carol Fleishauer

TECHNOLOGY PLANNING AND ADMINISTRATION

The Systems Office serves the technology support needs of the MIT Libraries. We manage web servers, the Barton library system, desktop workstation networking & support, and the computer-related capital equipment purchasing and installation process. Our staff works with staff around the libraries to accomplish these tasks. Local Technology Experts in each of the departments of the libraries, for example, help us troubleshoot and support desktop workstations. Staff at every level of the libraries help maintain our web sites. Recently we've even encouraged staff in another department of the libraries to help us write reports for Barton. Our job is to facilitate the effective and appropriate use of information technology tools around the MIT Libraries.

This year the staff of the Systems Office endured a great deal of turmoil as virtually the whole staff departed the libraries and the task of rebuilding the Systems Office anew began. The staff of the MIT Libraries generously lowered their expectations during this difficult time; but even so, the Systems Office moved the technology agenda of the MIT Libraries forward.

MAJOR REORIENTATION OF THE OFFICE

Our Systems Office has been rededicated to customer service. We are a support organization for the MIT Libraries, facilitating its efficient and appropriate use of information technology. We've put in place a two day response period to emphasize to libraries staff that they should hold us accountable. We have also taken steps to make ourselves more visible to libraries staff.

As one of the libraries' six strategic initiatives for the year, we developed a creative solution to the dilemma of an increased need for desktop workstation support without an increase in Systems Office staff. Each department of the libraries now has a Local Technology Expert who works with our Systems Office to troubleshoot and support desktop workstations. We have also worked with Public Services and Collection Services to define Information Technology Librarians who will work with the Assistant Director of Technology Planning and Administration to develop computing policy for the libraries.

During this fiscal year most of the Systems Office staff left the libraries. In an office that was by all accounts understaffed even when fully staffed, we finished the fiscal year with just two of five positions permanently filled. While the Local Technology Expert structure should help bear the load over time, right now those staff also need training from the Systems Office, making local support at best a break-even proposition this year. Hiring a Workstation & LAN Support Coordinator has been critical to our ability to function during this extremely short-staffed time. In the coming months we must hire staff to fill our three vacant systems positions.

LIBRARIES WEB SITE REDESIGNED

Consultants helped us redesign the libraries public web site. We now have a new design that encourages greater consistency of approach to our web pages and provides tools to maintain lists of resources without writing actual web pages. The new design also provides a more professional polish to the site. In the coming months we will move all public web services to the "libraries.mit.edu" server from the "nimrod.mit.edu" server and define a clear structure for management of web services and content within the MIT Libraries.

IMPROVED BARTON, THE LIBRARIES' CATALOG

We continue to improve our online catalog, Barton. All of our bibliographic records were sent to Blackwell North America for "authorities" processing. This project, another of the libraries' six strategic initiatives for the year, will add "see" and "see also" references to our catalog for the first time since we left our cards behind in the 1980's. The processed records will be loaded back into our database during August 1997 and we will continue to process records on a regular basis from then on.

We also developed and tested a web interface for our Barton catalog. Unfortunately the test showed that the Z39.50 server provided by Geac (our library system vendor) still had some problems, so we couldn't roll the system out for public use. But the effort puts us at the ready to offer this service once we have an upgrade from Geac.

Finally, we tracked down and resolved a problem that was limiting us to fewer than 90 simultaneous users on Barton. Our library system has been much more stable since this resolution.

ELECTRONIC RESERVES, A PILOT PROJECT

We developed a pilot electronic reserves (e-reserves) page on the web for course 21A.230J "The Contemporary Family." Materials usually kept on reserve for this course were also scanned by our Document Services department and then mounted as Adobe Acrobat documents on a web server in the libraries. Students in 21A.230J were given a password to access, view, and print these reserve materials from any workstation with a web browser and Acrobat Reader on MITnet. The lessons we learned from this experiment will help us build a scaleable e-reserves project in the coming year. We plan to work closely with MIT Information Systems to provide faculty with a tool to give their classes online access to required reading.

DESIGN OF A LIBRARIES-WIDE LAN

Though virtually all computers within the MIT Libraries are attached to MITnet, we do not have any tools which facilitate staff working together or make available a common suite of software. Putting a libraries-wide "local area network" (LAN) in place has been a long-standing goal. This year we designed, specified, and purchased equipment for a new libraries-wide Windows NT LAN. The servers for this LAN are now in operation. New equipment we roll out this summer will be attached to the LAN. We will upgrade existing equipment to work with the new LAN during the next year.

A number of divisional libraries also have small public LANs, used mostly to distribute CD-ROM applications within each library. This year we migrated the Dewey and Humanities public-access CD-ROM networks to a new and more stable version of Lantastic's local area networking software.

As we provide more common software and services centrally, we will also need to coordinate our computer-related capital equipment planning process with our strategic direction. To this end we plan to work more closely with libraries departments early in the fiscal year to help define their priorities and ensure that equipment we purchase for them moves them toward their goals.

STRATEGIES FOR SUCCESS

Working with libraries staff. Involve other libraries staff, particularly the Local Technology Experts, in the work of systems. Engage staff in system-wide training efforts and installation rollouts. Make sure they receive the backup and training they require.

Coordination with MIT Information Systems. Work closely with central MIT Information Systems staff whenever possible, particularly with regard to our e-reserves efforts. Determine what our common agendas may be and make sure we are leveraging each other well.

Training for AD and SO staff. Take advantage of MIT and other training for both the new Assistant Director for Technology Planning and Administration and the Systems Office staff. Especially seek training in team building.

Eric Celeste

LINCOLN LABORATORY

Lincoln Laboratory is operated by MIT as a Federally Funded Research and Development Center for performing research and development in advanced electronics. During the past year, agencies of the Department of Defense (DoD), namely, the Air Force, the Army, the Navy, the Defense Advanced Research Projects Agency (DARPA), and the Ballistic Missile Defense Office (BMDO), supplied approximately 80% of the Laboratory's budgetary support. The Federal Aviation Administration (FAA) provided most of the non-DoD support, which also includes work for the National Aeronautics and Space Administration (NASA) and the National Oceanographic and Atmospheric Agency (NOAA). Lincoln Laboratory also carries out precompetitive research with industry under approved Cooperative Research and Development Agreements. For the federal fiscal year 1996, Lincoln Laboratory received \$317 million, supporting the efforts of 1067 professional technical staff.

The following administrative changes occurred at the Laboratory Steering Committee level during the year: Mr. Frank D. Schimmoller became the Chief Financial Officer and Mr. Buckner M. Creel became Associate Head of the Administrative Division.

Activity at the Laboratory focuses on surveillance, identification, and communications technology development for the DoD, 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; 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

Lincoln Laboratory continues to support DARPA and the U.S. Air Force Wright Laboratory in their efforts to develop a foliage-penetration (FOPEN) synthetic aperture radar (SAR) system for the detection and discrimination of stationary ground targets that are obscured by foliage. Using data collected in 1995 by the Naval Air Warfare Center/Environmental Research Institute of Michigan P-3-aircraft-mounted ultrawideband SAR, Lincoln Laboratory has confirmed and extended earlier encouraging results applying change-detection and discrimination algorithms to the FOPEN automatic target recognition problem. Lincoln Laboratory is directing a DARPA-sponsored experiment planned for August 1997 that will utilize the P-3 SAR as well as the Swedish CARABAS II VHF SAR. Data from this exercise will allow comparisons between VHF and UHF SARs for detecting foliage-obscured targets.

Lincoln Laboratory has been supporting DARPA in the development, implementation and test of technologies and systems for detecting and recognizing stationary and moving ground targets using SAR imagery and moving target indicator (MTI) radar measurements. The Laboratory was a key participant in the development of a semiautomated system (only a few operators) for real-time exploitation of the large quantities of SAR imagery provided by current and future wide-area SAR systems. The baseline phase of this system, referred to as the Semi-Automated IMINT Processing (SAIP) system, was completed in the Spring of 1997 with an engineering evaluation in connection with field exercises at the National Training Center in California and the White Sands Missile Range in New Mexico. Current activities focus on an enhanced system to be completed in the Fall of 1997. The exploitation of SAR imagery for stationary targets is complemented by the development of technologies and system concepts for recognizing moving targets via radar-based one-dimensional (range profile) and two-dimensional, high-resolution images.

Lincoln Laboratory is responsible for the design, development, and demonstration of the Advanced Land Imager (ALI) that will be incorporated on the National Aeronautics and Space Administration's (NASA) Earth Orbiter-1 mission now scheduled for launch in May 1999. ALI will demonstrate advanced technology to reduce size, weight, and power requirements in order to meet NASA's Mission to Planet Earth science needs in the 21st century.

Lincoln Laboratory is collaborating with the MIT Civil and Environmental Engineering Department in remote monitoring of in-situ contamination using optical spectroscopy. This work uses miniature, fiber-coupled UV lasers to excite fluorescence in organic pollutants such as benzene, toluene, and xylene. The ultimate objective of the research is to develop a multiprobe system for long-term monitoring of contaminants in soils and ground water. This past year, field measurements were conducted to explore the performance of a single filter probe in realistic

contaminated-soil conditions. In addition, lab measurements were conducted to investigate laser-induced-breakdown spectroscopy with microlasers.

In collaboration with the MIT Department of Earth and Planetary Science and the Haystack Observatory, Lincoln Laboratory has been investigating the feasibility of using the Haystack Long Range Imaging Radar (LRIR) to detect and track near-earth asteroids (NEAs). In the course of this investigation the LRIR successfully observed asteroid 4179 Toutatis at the range of 5.28 million kilometers. NEAs are potential targets for scientific exploration and could represent a possible collision threat. In the future, an upgraded Haystack Radar could be used to provide precise range and Doppler measurements on newly discovered NEAs to support cataloging efforts and asteroid exploration missions such as Clementine 2.

MISSILE DEFENSE

The Theater High-Altitude Area Defense (THAAD) system is currently undergoing field testing. The system is designed to provide large-area defense against theater ballistic missiles. During the past year, Lincoln Laboratory provided support to several key aspects of THAAD radar development. This sensor provides the surveillance and fire control for the THAAD system and came on-line early in the year. Laboratory support includes testing and analysis of the THAAD radar baseline discrimination architecture, characterization of radar performance, and analysis of the radar performance during THAAD flight tests at White Sands Missile Range for government evaluators. It also includes data analysis and performance evaluation of the THAAD radar for the Theater Missile Defense Critical Measurements missions conducted at Kwajalein.

The Kwajalein Missile Range (KMR), for which Lincoln Laboratory serves as Scientific Advisor, is preparing to support testing of theater missile defense components and measurement programs aimed at acquiring data essential to the development of advanced ballistic missile defense capabilities. The Laboratory has provided the U.S. Army Space and Strategic Defense Command, the sponsor of KMR, with a five-year plan for the modernization of the instrumentation assets. This effort, which will begin in FY98, will result in a more efficient operation of the measurement facilities through use of a common set of signal processing subsystems, central computers, recording systems, and software. It will result in the ability to develop software, carry out system health diagnostics, and conduct mission operations remotely from the Kwajalein Control Center and thereby reduce the commuter flights between Kwajalein and Roi Namur Islands. The Laboratory will continue to support KMR from Lexington in the test planning of missions and in the reduction and analysis of data.

Lincoln Laboratory is developing the prototype COBRA GEMINI radar system, which will be used to acquire data in rest-of-world (ROW) ballistic missile launches. Since the end of the Cold War and dissolution of the Soviet Union, the missile data collection effort has been focused on ROW countries rather than on Soviet systems. This air transportable mechanical scanning dish radar is also designed for operation on a TAGOS ship. COBRA GEMINI will be available for testing in 1998.

Over the past several years, Lincoln Laboratory and the Advanced Electronic Guidance and Instrumentation System (AEGIS) PMS-400 office have been supporting the development of the Navy Area (or lower tier) Theater Ballistic Missile Defense (TBMD) system. Much of the early work covered an analysis of AEGIS performance in autonomous and cued search modes. The studies quantified the cueing accuracies of systems such as the Defense Support Program satellites, netted AN/SPY-1 and Patriot radars, and airborne Infra-Red Space Telescope/Laser Detection and Ranging sensors. The AN/SPY-1 firm-track ranges and SM-2/BLK-IVA flyout capability were then related to potential defended footprints against a wide class of TBMs.

More recent work has covered a TBM debris environment characterization based on the measurement data base. Data from a number of sensors such as the Kwajalein radars, COBRA JUDY, and the Airborne Surveillance Testbed were used to quantify the radar and IR characteristics of TBM debris. The results of the analysis have been used to define system requirements for the Navy Area TBMD system. Current work focuses on the development of discrimination algorithms and timelines for the system.

More recently the Laboratory has begun systems analysis work for the Navy Theater-Wide (or upper tier) TBMD and Anti-Air Warfare Programs. This work has included an assessment of potential radar and IR discrimination metrics in the exoatmosphere. Other work has covered an analysis of new sensors and techniques for area defense

against low-altitude cruise missiles. The results are being used to plan an acquisition strategy for developing new Navy surveillance and fire control systems.

AIR DEFENSE TECHNOLOGY

The Radar Surveillance Technology Experimental Radar (RSTER) system was redeployed at the Makaha Ridge site on the Pacific Missile Range Facility after the Cruise Missile Defense Advanced Concept Technology Demonstration Phase I (ACTD phase I) demonstration in order to continue the Navy/DARPA-sponsored advanced early warning (AEW) technology testing and demonstration. Data collection and analysis during 1997 includes the development and demonstration of advanced wideband and narrowband waveforms, beam forming and target-tracking techniques, and phenomenology data to support cruise missile defense. The summer of 1997 campaign will involve sensitivity and system stability verification, interference rejection, metric accuracy determination, and scenarios with simulated low-flying cruise missiles.

The Airborne Seeker Test Bed (ASTB) is based in a Gulfstream II aircraft which 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 powerful insights into the performance of sensor systems and advanced signal processing algorithms.

Improvements to the aircraft's internal computer network and real-time signal processing capabilities have enabled the in-flight demonstration of advanced countermeasure algorithms and better control and combination of data from the increasingly more intricate network of sensors. FY97 saw the addition of a new RF seeker pod which has been used in two major measurement campaigns in Nevada for a total of 26 data collection flights. During the most recent campaign the Test Bed passed the 400th mission mark. Near-term plans include two IR measurement campaigns in September and October, followed by the addition of two new IR seeker pods.

The modern battlefield requires that airborne early warning surveillance platforms, such as the E-2C, detect small targets in the presence of severe jamming and sea/land clutter. Adaptive signal processing techniques, such as space-time adaptive processing (STAP), enable enhanced target detection capability in the presence of clutter and jamming. These techniques use multiple receive antenna channels and digital signal processing algorithms to shape the receive beam pattern in the spatial and doppler domains. The current E-2C APS-145 radar has two receive channels. A significantly higher number of receive channels are required for STAP processing. Digital receiver technology will significantly reduce the receiver form factor by sampling directly at the RF frequencies and by eliminating most of the analog components. The down-conversion and the in-phase/quadrature signal generation are digitally performed by using a high-performance VLSI signal processor.

A single-board demonstration of the digital receiver concept has been completed. The receiver consisted of RF front-end circuitry, a high-speed analog-to-digital converter (ADC), and a VLSI digital down-conversion chip set. An 8-bit 3-GSPS Rockwell ADC was used for the initial prototype. For the digital down conversion, approximately 65 billion operations per second (GOPS) were required per channel. A full custom CMOS VLSI digital down-conversion chip set was developed using a very high performance scalable bit-level systolic cell library. Each chip in the chip set functions as a massively parallel signal processor and consists of tens of thousands of 1-bit processors. By using massively parallel signal processing, each chip can perform up to 45 GOPS using an established 0.6- μ m CMOS fabrication process. In the near future, the scalable bit-level systolic array cell library will be adapted to smaller feature sizes, which will enable the entire down-conversion process to be accomplished with a single chip.

COMPUTER-BASED RECOGNITION TECHNOLOGY

Under the Advanced Distributed Simulation Program, funded principally by DARPA and the Defense Modeling and Simulation Office (DMSO), Lincoln Laboratory developed software for a prototype run-time infrastructure (RTI) for linking together a broad range of DoD models and simulations. This software is a key element of the DoD High-Level Architecture for Modeling and Simulation, which is now required for all future DoD simulation applications. The prototype RTI software is being used in the Fall of 1997 in a major demonstration of DARPA's Synthetic Theater of War (STOW) program, an Advanced Concept Technology Demonstration (ACTD) being developed for use by the U.S. Atlantic Command (ACOM) in joint training exercises.

An enhanced version of the Lincoln Laboratory speaker identification system was tested along with systems from seven other laboratories in the 1997 National Institute of Standards and Technology (NIST) evaluation, and for the second consecutive year the Lincoln Laboratory system scored best in all categories. The Laboratory system was a Gaussian Mixture Model system with Universal Background Model and handset normalization. As an example of the results, for 30-second utterances with training and testing on the same handset, the Lincoln Laboratory system achieved a false-alarm rate of 1.5% at a 10% probability of a miss.

Lincoln Laboratory's English/Korean translation system has been significantly enhanced, and has been demonstrated at Combined Forces Command (CFC), Korea, at the April 1997 coalition exercises. A multi-stage, robust translation approach has been developed, which integrates state-of-the-art language understanding and generation technologies with specific adaptation of the system to the military domain. The system is currently being adapted for translation of the Commander's briefing material, in preparation for a capability demonstration of translation of operational material at a Fall 1997 coalition exercise at CFC.

Lincoln Laboratory completed an extensive analysis of a widely fielded intrusion detection system, based on four months of data provided by the Air Force Information Warfare Center (AFIWC) and found that the existing intrusion detection system only weakly discriminates serious incidents from normal user activity. The average number of transcripts human analysts must look through to detect one serious intrusion ranges from 310 to 4600 across different Internet services. This high ratio of false alarms to true hits implies many human analysts and person-hours would be needed to find true intrusions. To begin addressing this problem, Lincoln Laboratory has developed a new intrusion detection algorithm which searches transcripts of telnet sessions to detect suspicious cases where a user illegally obtains root-level privilege. This new algorithm was tested on the same four months of data, and detected 16 serious incidents where unauthorized users illegally gained root privileges. Human analysts examining these transcripts, it is believed, would have detected only one or two of these serious attacks. The new algorithm, by analyzing the sequence of events in telnet sessions and detecting where illegal transitions to root status are made, achieves dramatic improvements in performance over existing intrusion detection algorithms which rely primarily on key-word detection and do not parse or analyze the sequence of events in a user session.

Computational models of the human visual system (HVS) are being used as the basis for algorithms to compress, enhance, fuse, and display many different kinds of imagery for diverse applications. These include advanced color night vision based on the fusion of low-light visible and IR imagery, and exploitation aids for remote surveillance imagery, including synthetic aperture radar (SAR), IR, and electro-optical (EO) imagery. The fusion work on night vision has led to some initial experimentation with similar algorithms to combine multi-platform and multi-sensor surveillance data to produce superior image products for image analysts. Initial experiments have involved combining visible and SAR monochrome images into color-fused images for use by image analysts. The process involves image registration to compensate for different imaging geometries followed by HVS-based image enhancement and fusion algorithms. The superiority of fused imagery to either type of component imagery has been successfully demonstrated.

Processing requirements for computer-based recognition can range from modest to very large, depending upon the specific algorithm and the rate at which data must be interpreted. A goal of the Lincoln Portable Scalable Multiprocessor Software project is to demonstrate how to build efficient multiprocessor recognition software that is relatively easy to develop in the first place, scales easily with problem size (i.e., number of processors required to perform the task at hand), can easily take advantage of higher-performance processor hardware as it becomes available, and can be run in embedded real-time systems as well as on workstations and commercial off-the-shelf (COTS) multiprocessors. A message-passing programming model was selected to achieve these goals. A subset of the Message Passing Interface (MPI) standard for interprocessor communication was selected to support project goals while being small and fast enough for use in embedded systems. The subset was implemented for a commercial multiprocessor board for demonstration purposes. Several algorithms were coded using the MPI subset and the C programming language. These were then demonstrated to operate on networks of COTS workstations and on other multiprocessor systems with the number of processors ranging from 4 to 32. The MPI system was also instrumented to produce log files from which graphical performance (computational and communication) displays are generated for debugging and code optimization.

COMMUNICATIONS AND NETWORKING

The Wideband All-Optical Networks wavelength-division multiplexing (WDM) effort consists of developing architectures, technology components, and a test bed for the realization of scalable, high-speed (user data rates from 10 Mbps to 10 Gbps), high-capacity (~Tbps) transparent optical WDM networks. The architecture addresses all-optical transport over wide, metropolitan and local areas utilizing wavelength partitioning, wavelength routing, and active multiwavelength cross-connect switches to achieve a network that is scalable in the number of users, data rates, and geographic span. The network supports three optical services which can be point-to-multipoint, or multipoint-to-multipoint simplex or duplex connections. A 20-channel local and metropolitan area WDM test bed has been developed and deployed in the Boston metropolitan area based on these architectural principles using advanced components. Multiple rate and format connectors over a variety of optical services and over 130 Gbps of capacity through a metropolitan area hub have been demonstrated. A full all-optical network (AON) control and management system has also been developed and implemented.

In March 1996 the Advanced Technology Demonstration Network (ATDNet) was initiated to integrate AON technology into Washington, D.C. ATDNet is a DoD-sponsored networking initiative with six principal network nodes: the National Security Agency, Naval Research Laboratory, Defense Information Systems Agency, Defense Intelligence Agency, NASA, and DARPA. During this year, successful integration of the AON with ATDNet was accomplished. The interoperation of ATDNet with an advanced technology test bed from AON components is providing an early indication of the efficacy of AONs in a realistic DoD setting. Quantitative information concerning the utility, performance transparency, and the major increase in capacity of the WDM network was obtained. Practical issues involving use of commercial fiber circuits with the AON were resolved. Field evaluation of the two networking technologies is providing important qualitative and quantitative results for guiding future architecture, technology, application development, and procurement decisions.

The Military Communications Technology Program is responsive to evolving satellite communications service trends and challenges. One need is to lower costs via smaller, lighter-weight implementations. A performance-related goal is to increase capacities (especially to small, mobile terminals), allowing for interoperable networking (where satellite communications extend national/international information networks to remote areas and/or mobile users) and achieving robustness against co-user as well as intentional interference.

During this year, technical concepts and designs were accomplished for a tactical theater communications system utilizing airborne platforms as switching and routing nodes in a data network serving terrestrial users. Individuals with small, handheld radios will be able to link into the network through the airborne platforms; these platforms are interconnected by high-rate backbone circuits and then joined to entry points on the ground where interconnection with terrestrial (commercial and military) communications systems can be accomplished. Since the aircraft can be quickly flown into an area of operations, reducing logistic needs in establishing a communications capability on the ground. The network is also able to cover large areas from a single high-flying aircraft and is thus able to link together widely dispersed military units. The technology employed in such a system is derived from the Internet data networking technology and the satellite communications technology developed at the Laboratory.

AIR TRAFFIC CONTROL

By developing planning aids for air traffic controllers, Lincoln Laboratory is helping the FAA to enhance air safety, reduce controller workload, and increase airport capacity. The Center/TRACON Automation System (CTAS) helps coordinate activities between arrival controllers located at en route centers and final approach controllers located at airport radar control facilities.

Lincoln Laboratory has continued to support the FAA with the development of the CTAS Build 2 System specification, delivered in February 1997. This will provide information to final approach controllers to optimize arrivals. Additional work is now in progress for developing En Route Air Traffic Management Decision Support Tool (ERATMDST) specification by the Fall of 1999. This ERATMDST specification will describe the integration of ATM decision support tools such as Conflict Probe, Descent Advisor, and Traffic Management Advisor.

A new Lincoln Laboratory program has been initiated with NASA Ames Research Center under the Advanced Air Transportation Technologies program. The main purpose of the program is to investigate incorporating advanced weather products from systems such as the Integrated Terminal Weather System (ITWS) into air traffic automation

tools such as the CTAS. An initial objective is to integrate the ITWS Terminal Winds product into the Final Approach Spacing Tool (FAST). The use of improved winds information will allow the FAST system to compute more accurate trajectories and should therefore improve performance.

Additional work is in progress relating to the User Preferred Routes and Expedite Departure Path projects. Investigations will be undertaken on incorporating convective weather products into these CTAS tools. The objective of this work is to allow dynamic rerouting of aircraft around storms in an efficient manner.

The Mode S radar beacon system was developed, prototyped, and tested at Lincoln Laboratory for the FAA and has been deployed at 137 sites nationwide. Mode S has an integral air-ground digital data link, and Lincoln Laboratory has developed data link applications for use by air transport and general aviation aircraft. The Traffic Information Service provides pilots with the location of nearby aircraft by uplinking surveillance information gathered by the Mode S radar. The Text Weather Service and Graphical Weather Service provide pilots with weather text and graphics uplinked via Mode S from ground-based weather sources, including weather radars. These data link applications have been implemented in an operational Mode S radar at Dulles International Airport and evaluated by representatives of the airlines and the general aviation community. The FAA will deploy the traffic information service nationwide by the end of 1997 and is considering national deployment of the weather text and graphics applications on the Mode S or a VHS data link. Several airlines are participating in a demonstration of text data link products derived from the Terminal Doppler Weather Radar and transmitted via a VHF data link.

A continuing multiple-year program to improve the FAA's ability to detect and predict weather conditions that impact aviation utilizes test bed sensors and advanced signal and data processing. The Terminal Doppler Weather Radar (TDWR) and ASR-9 Wind Shear Processor (WSP) systems provide wind shear information automatically to air traffic controllers and pilots. Lincoln Laboratory is supporting the refinement of the TDWR wind shear detection algorithms and adding a storm motion product to the Laboratory-designed TDWRs now deployed at major airports. The Laboratory-designed signal processing algorithms for estimating low-altitude Doppler velocity with fan beam radars enable the FAA's Airport Surveillance Radars (ASR-9) to provide similar wind shear warning and storm motion information at the nation's medium-density airports. The Laboratory-designed technology is being transitioned to the ASR-9 WSP full-scale developer.

The Laboratory-developed ITWS delineates hazardous airspace conditions and provides short-term forecasts of significance to aviation by integrating information from the FAA, the National Weather Service, and airline sensors (e.g., radars, lightning, winds). The Laboratory is supporting technology transfer of the ITWS product generation algorithms to the ITWS Flight Standards District Office contractor. The Laboratory is continuing to operate ITWS test beds in Memphis, Orlando, and Dallas-Fort Worth to increase the ITWS data base and test enhanced products (e.g., thunderstorm growth and decay predictions) as they become available. An additional experimental site in San Francisco supports the development of ceiling and visibility prediction products.

ELECTRONIC DEVICES

Working with the MIT Center for Space Research, the Lincoln Laboratory Microelectronics Group successfully completed the imaging spectrometer for NASA's Advanced X-ray Astrophysical Facility in March of this year. The image array consists of 10 large (1048 x 1048-element) charge-coupled-devices (CCDs) which were specially fabricated to be very sensitive to x-rays from 250 to 10,000 eV in energy. New techniques were created to fabricate the CCDs, and also to assemble them in the precision multi-device focal plane array. The flight array has successfully completed all its preflight tests at NASA Marshall Space Flight Center and is currently undergoing integration into the spacecraft. Advanced X-ray Astrophysical Facility (AXAF), which is one of the three NASA Great Observatories (the other two are the Hubble and the Compton Gamma Ray Observatory), is scheduled for launch on the shuttle in August 1998.

The fabrication of integrated circuits (ICs) with feature sizes of 180 to 250 nm required the development of new high-resolution optical lithography equipment and processes. Lincoln Laboratory, in collaboration with equipment manufacturers, has developed a prototype 193-nm-wavelength large-field optical stepper and has installed it in the Microelectronics Laboratory. This system has demonstrated 175-nm patterning using conventional chrome-on-quartz photomasks, and has achieved 100-nm patterning using phase-shift masks. In addition, researchers have built

a 157-nm-wavelength illuminator as a tool for further reducing pattern features, and have recently produced 80-nm lines.

The 193-nm excimer lithography is approaching commercial acceptance, but the exploitation of the technology by IC manufacturers is still about two years away. As a look into that future, Laboratory researchers have used the prototype 193-nm tool in their state-of-the-art fabrication facility to define all eleven masking layers in a low power, high-performance, silicon-on-insulator CMOS process. First-pass success was achieved on both test devices and simple circuits with inverter delays of 29 ps at 3.0 V and 57 ps at 1 V. This represents a 10x reduction in power consumption and 2x improvement in speed performance when compared to a conventional 0.5- μ m technology.

Early warning of a potential biological attack is an essential capability for an effective biodefense system. Lincoln Laboratory has developed a real-time, point, bioaerosol sensor for early warning of threat aerosols and has successfully demonstrated its effectiveness in field tests performed in September 1996, in which *Bacillus subtilis* was used as a simulant of a biowarfare agent. The tests demonstrated that the discrimination capability of the sensor was effective in reducing the false-alarm rate due to the presence of natural biological and nonbiological aerosols.

The sensor is based on laser-induced fluorescence detection of aerosol particles and incorporates two spectral channels for discrimination of threat aerosols from background aerosols. The UV source of excitation is a miniature diode-pumped, passively Q-switched Nd:YAG laser that is frequency quadrupled to 266 nm. Air to be sampled is drawn by a fan to a region illuminated by the laser. Fluorescence emitted by a particle intercepted by the UV laser beam is simultaneously observed in a UV and a visible channel, and the ratio between the signals from the two channels provides discrimination information.

W. E. Morrow, Jr.

SCHOOL OF ARCHITECTURE AND PLANNING

During the 1996-97 academic year, the School of Architecture and Planning vigorously continued to improve its core physical facilities, to develop new computer and digital telecommunication capabilities, to sponsor new ventures in research and teaching, and to build and renew its faculty. These efforts are expected to position the School as a strong leader into the 21st century.

FACULTY

Faculty development and renewal remains a top priority. During 1996-97 there were important faculty appointments in all units of the school.

In the Department of Architecture Krzysztof Wodiczko was promoted to Full Professor and Julie Dorsey was promoted to Associate Professor. N. Michael McKinnell joined the faculty as Adjunct Professor, Chris Luebke joined the faculty as Assistant Professor, and Dennis Adams was appointed Associate Professor with tenure. Peter Testa, previously a Visiting Associate Professor, was appointed Associate Professor effective July 1, 1997. Ann Pendleton-Jullian was named the inaugural holder of the Alfred Henry and Jean Morrison Hayes Career Development Chair. Professors Maurice Smith and John Myer completed their terms of employment.

In Media Arts and Sciences Bruce Blumberg joined the faculty as an Assistant Professor and holds the Asahi Broadcasting Corporation Career Development Chair. Assistant Professor Justine Cassell has been named to the AT&T Career Development Chair.

The Department of Urban Studies and Planning hired Jennifer Davis as Assistant Professor. She will be joining the faculty in 1998. Associate Professor Lawrence J. Vale was granted tenure and Qing Shen was appointed Mitsui Career Development Assistant Professor.

Stephen A. Benton, E. Rudge ('48) and Nancy Allen Professor of Media Arts and Sciences, became director of The Center for Advanced Visual Studies on July 1, 1996.

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. However, it is easy to slip in these efforts, so we continue to apply aggressive recruitment efforts in every faculty search.

Two special fellowship programs in the Department of Urban Studies and Planning; the Community Fellows Program and the SPURS Program bring to the School mid career practitioners from minority communities, who work in urban and regional development in the United States, and in developing countries, to study and pursue independent research.

SPACE

Last fall, the major renovations of design studios continued in the area surrounding the dome on the fourth floor of building 7. As a result, the majority of the Architecture studios are being taught in new space, the new cafe and public areas have become lively and successful social centers, and the architectural quality of the new space has been recognized by a Design Citation from the New England Chapter of the American Institute of Architects.

Further renovations of research and teaching spaces, in completion of the School's phased master plan, are continuing and will continue to improve the quality of student workspaces, computing facilities and classroom and teaching spaces for the Departments of Architecture and Urban Studies and Planning.

EDUCATIONAL INITIATIVES

After evaluating the undergraduate curriculum, the Department of Architecture has reorganized the process of advising undergraduates and is planning changes in undergraduate teaching. With the support of a grant from the Graham Foundation, the Department of Architecture is exploring ways to incorporate landscape more fully into the curriculum. This year the Visual Arts Program graduated its first students with the Master of Science degree in Visual Studies. The program continues to evolve and is planning to institute a visiting artist program.

Currently the Program in Media Arts and Sciences (MAS) does not offer an undergraduate degree, however, they continue to explore several options which will enable them to institute an undergraduate program in the future. During the past year MAS faculty and staff offered nine undergraduate subjects, conducted freshman seminars, and served as freshman advisors. MAS continues to provide an extraordinary number of positions to undergraduates in the Undergraduate Research Opportunities Program.

The Department of Urban Studies and Planning's Undergraduate Committee is developing a proposal for a new interdisciplinary Minor in Public Policy, targeting students majoring in science and engineering. This initiative will require the cooperation of the Political Science and Economics departments, as well as other departments. The department hopes to have their proposal under consideration by the necessary MIT committees during the 1997-98 academic year. The department offered four more for-credit courses during the Professional Development Institute held during the Independent Activities Period than they offered last year. These for-credit and non-credit offerings attracted over 300 students, alumni/ae, and local professionals.

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 and social issues.

This year in the Department of Architecture The Arthur H. Schein Memorial Lecture was given by Ada Karmi-Melamede. N. Michael McKinnell, Adjunct Professor, gave the Pietro Belluschi Lecture. Andrew Scott organized a major symposium on "Dimensions of Sustainability." Invited for a three week residency, the conceptual artist, Lawrence Weiner, conducted classes, workshops, and gave a public lecture. Julie Dorsey won the prestigious Edgerton Award. Fernando Domeyko won a design competition for a church in Chile while Dennis Adams, Krzysztof Wodiczko, Ritsuko Taho, and Barbara Broughel received public art commissions. A Festschrift was held to honor Stanford Anderson. The symposium brought in speakers and attendees from around the world and marked the publication of a collection of essays by his colleagues and former students, *The Education of an Architect*, (M. Pollak, Ed.), honoring his contribution to the field.

In the Program in Media Arts and Sciences Professor John Maeda was awarded the 1996-97 Tokyo Type Director's Club Gold Prize for 10 Morisawa Posters exhibited at the Ginza Graphic Gallery in August 1996. Professor Pattie Maes was named one of the 1997 "100 Global Leaders of Tomorrow" by the World Economic Forum and Seymour Papert, LEGO Professor of Learning Research Emeritus, was named the winner of this year's NEC Leadership Award for Education by the Smithsonian Institution.

The Karl Taylor Compton Lectures were sponsored, in part, by The Department of Urban Studies and Planning. This series of three lectures was delivered by Dr. Oscar Arias Sánchez, Nobel Peace Laureate and former President of Costa Rica. The Department of Urban Studies and Planning received a plaque honoring the founder and first chair of the Department, Professor Frederick J. Adams, from The American Institute of Certified Planners, the Society for American City and Regional Planning History, and the Massachusetts Chapter of the APA.

The Aga Khan Program for Islamic Architecture held three international conferences and a roundtable discussion during the academic year. In the fall Acting Director Attilio Petruccioli and Associate Professor Nasser Rabbat organized the roundtable discussion, "From Antiquity to Islam in the Cities of al-Andalus and al-Mashriq." The international conferences were "Urban Triumph or Urban Disaster? Dilemmas of Contemporary Post-War Reconstruction," organized by Jon Calame and Esther Charlesworth; "Bukhara: the source, the Myth, the Architecture and the Urban Fabric" and "The Courtyard House and Urban Fabric," both organized by Professor Petruccioli.

The Center for Real Estate hosted a well received seminar organized and led by member Robert Danziger, retiring Chairman of Northland Development.

The Center for Advanced Visual Studies has been collaborating with Instituto de Soldadura e Qualidade of Lisbon, Portugal, as well as with present and former Fellows of the Center to provide a proposal to the management of

Expo'98 (Lisbon) for a stand-alone public art exhibition to be presented next summer at Expo'98. The project is still in development.

The Ralph Adams Cram Award for outstanding interdisciplinary work at the Master's level was presented to Rupinder Singh, graduate of the Department of Architecture, for his thesis "Piranesi's *Campo Marzio* Plan: The Palimpsest of Interpretive Memory."

This year marked the first full year of exhibits in the School's new Wolk Gallery. Curator of Architecture at the MIT Museum, Kimberly Shilland, organized three shows during the academic year: *The Work of Eduardo Catalano*, *Ritual Architecture in India*, and *A Sense of Place, A Sense of Time: Drawings by J. B. Jackson*.

More information about the School of Architecture and Planning can be found on the World Wide Web at the following URL: <http://sap.mit.edu/>.

William J. Mitchell

DEPARTMENT OF ARCHITECTURE

The Department of Architecture continues to maintain and enhance its role as one of the eminent professional schools of architecture, with a mission to provide students instruction in history, technology, and the arts, as well as the many domains of the discipline of architecture. By "discipline" we understand the full constituency of architecture to be much broader in scope than the profession; on a department level "discipline" refers not only to architectural design but also to the other distinctive domains of our program: visual arts, building technology, and history, theory, and criticism of art and architecture. We are committed to a leading role in the exploration of new technologies and electronic communications in relation to our physical and social environments.

The discussion below is organized by discipline group, followed by individual topics that cross discipline areas.

ARCHITECTURAL DESIGN

Level I studios benefited from increased coordination among the studios. Beginning Level II studios concentrate now on tectonics and strengthened links with the building technology section. Upper level option studios and workshops continue to offer a choice of in-depth or large-scale projects, often involving study of international sites. This past year students traveled to Spain, Thailand, India, Washington, DC. A student travel policy is expected to encourage participation in such opportunities while also supporting the curriculum of non-traveling studios and classes.

Computational facilities now are installed throughout studios and research areas rather than collected in a central location, enabling their use as tools for design and analysis. Design Technology continues to refine its mission and means. William Porter and colleagues are developing innovative approaches to programming and the interaction of architect and client. The addition of George Stiny and Terry Knight to the faculty strengthens the effort in computation and design through the study of shape grammars. Takehiko Nagakura (with Kent Larson) is engaged in an intriguing research project in the visualization of unbuilt architecture. It is for work in this area of visualization that Julie Dorsey won the Edgerton Award.

Under the leadership of Hasan-Uddin Khan and Andrew Scott and with the support of a grant from the Graham Foundation, the department is exploring ways to incorporate landscape more fully in the work of the studios and the curriculum generally.

BUILDING TECHNOLOGY

The new research and teaching facility to study indoor air quality and air circulation in rooms is in operation under the direction of Qingyan Chen. The state-of-the-art lab can be used to study indoor air quality, thermal comfort, building energy analysis, and heating ventilating, and air-conditioning (HVAC) system control and design. Full scale room interiors can be simulated with a variety of heat sources and ventilation technologies. We are able to measure details of air movement, and pollution dispersion along with interactions of room occupants and equipment. Several research projects directed by Chen and Leon Glicksman are already underway in the facility to study air contamination from materials and new ventilation and cooling technologies which will produce much lower pollution concentrations with the same energy requirements. The facility is also being used to verify new computational schemes for the prediction of air movement in rooms. New wall insulation panels have been developed by Glicksman and Leslie Norford for use in developing countries. These panels use local waste materials to substantially reduce the energy requirements for existing buildings and can be made in the local area at less cost than currently available products.

Chris Luebke has joined the group to teach structures and building systems. His research seeks to expand the utility of the world wide web as a teaching and design resource for structures students and students in the design studios. Norford and Julie Dorsey have completed the initial phase of a computational tool to aid architects in designing windows to achieve desired lighting levels with maximum use of natural light. The method uses an optimization algorithm to size and locate windows to minimize the difference between desired and estimated lighting levels. The work will be extended to consider more complex lighting designs and more robust optimization approaches, including genetic algorithms. Our major need is additional supported Teaching Assistants to help support advanced graduate study in Building Technology.

HISTORY, THEORY, AND CRITICISM

Faculty and students continue to be well represented by publications and conference contributions in their fields. "Testing Ground, Contesting Space," an interdisciplinary graduate student symposium was organized jointly by MIT and Harvard Graduate School of Design and supported by a grant from the Graham Foundation. Preparations are underway for a major symposium to mark this section's 25th anniversary next year.

VISUAL ARTS

Five students were enrolled in the Master of Science in Visual Studies Program. The program graduated its first three students and accepted three new students. Sponsored by the Dean's Office, the Office for the Arts, the Department of Architecture and the Visual Arts Program, world-renowned conceptual artist Lawrence Weiner was invited for a three-week residency to experiment with the equipment in the visual arts "maclab." Mr. Weiner conducted classes and workshops, met informally with students and faculty throughout MIT, and gave a public lecture. The Visual Arts Program has plans to develop a comprehensive visiting artist program to explore digital and other technologies and to work with other universities.

UNDERGRADUATE PROGRAM

The department spent considerable energy this year to clarify the undergraduate curriculum and increase the visibility of the program, within and outside of the department. Advising of undergraduates has been reorganized and a group of enthusiastic faculty advisors has been recruited and trained. (Previously the major responsibility for advising lay with a now-retired faculty member.)

STUDENT AID

Competition for exceptionally talented and motivated students remains high. Developing the means to offer competitive packages to students choosing architecture, a field with long degree programs and low professional salaries, is a high priority. We are grateful for the recognition of this difficulty by the Institute. The building technology section in particular has articulated a need for increased TA opportunities to sustain its surging research programs.

SPACE: RENOVATION AND DEPARTMENT CONSOLIDATION

The Department was able to consolidate most of the studios in the newly renovated space in buildings 3 and 7, bringing these teaching programs back into proximity with the department administration, Rotch Library, and other discipline groups. Several studios, however, including undergraduate studios, remain in the satellite space in N51/52, along with some faculty offices and the visual arts program. The next phase will be underway during the summer of 1997. The department continues to cope with the necessary disruption to its faculty, staff and students, in support of the goal of unifying our department in the main complex.

AGA KHAN PROGRAM FOR ISLAMIC ARCHITECTURE

The Aga Khan Program (AKPIA) continues to thrive under the energetic leadership of Attilio Petruccioli, supported by the teaching of Nasser Rabbat and Sibel Bozdogan. While maintaining its traditional areas of research in Islamic environments, a new emphasis now concerns theoretical approaches and applications of technology for urban preservation. AKPIA Summer Travel Grants were awarded to Minakshi Mani and Lara Tohme.

PROGRAM ENROLLMENTS

A total of 67 undergraduates and 203 graduate students (including 94 MArch, 49 SMArchS, 2 SM without specification, 5 SMBT, 5 SMVisS, 26 PhD resident and 22 PhD non-resident) were counted in Course IV this year.

HIGHLIGHTS OF THE YEAR

Student Awards designated by the Department or Institute: The William Everett Chamberlain Prize for graduating BSADs for achievement in design (Dana Cho). The Sydney B. Karofsky '37 Prize for the outstanding Master of Architecture student with one further year of study (Scott Tulay, Sandra Ventura). The Francis Ward Chandler Prize for achievement in architectural design (Matt Noblett, Frederick Gutierrez). The Alpha Rho Chi Medal for leadership, service for the school and department, and promise of real professional merit (Steven Bull). The AIA Certificate of Merit for second-ranked master of architecture student (Lia Kiladis). The AIA Medal for the top-ranked master of architecture student (Alberto Cabre). The SMArchS Prize (Projjal Dutta, Joseph Press, Mark Sich, Akiko Takenaka). The Imre Halasz Thesis Award (Gerdur Sigfusson). The AIA Foundation Scholarship nominees

(James Bruneau, Teresa Tourvas). The Kristen Ellen Finnegan Memorial Award in History, Theory, and Criticism of Architecture (Juli Carson). Faculty Design Award (Sean Kwok, Andrew Plumb, Joy Wang). Schlossman Research Fellow (Juliet Koss). Ann Macy Beha Travel Award (Talin Der-Grigorian, Joel Turkel, Lana Yoon). Louis C. Rosenberg Travel Award (Eileen McHugh). Ralph Adams Cram Award (Rupinder Singh). Marvin E. Goody Prize (Joseph Charlson and Henry Harvey, co-winners; Robert Clocker; Alvise Simondetti). Royal Fund Award in Architectural History (Annie Pedret).

External Awards: American Association of University Women International Fellowship (Juliet Koss). Fisher Graduate Student paper Award in Turkish and Ottoman Studies (Shirine Hamadeh). Kress/ARIT Grant (Shirine Hamadeh). Skidmore, Owings & Merrill Foundation Traveling Fellowship (Matt Noblett was one of two semi-finalists nationally). Lady Davis Doctoral Fellowship (Alona Nitzan-Shifan). International competition sponsored by Alvar Aalto Museum (Joy Wang and Taffy Mwandiambara, third prize).

FACULTY

Krzysztof Wodiczko was promoted to Full Professor of Visual Arts. Julie Dorsey was promoted to Associate Professor of Architecture.

N. Michael McKinnell joined the faculty as Adjunct Professor of Architecture. Assistant Professor Chris Luebke joined the faculty in building technology, where he will focus on the teaching of structures and building systems. Dennis Adams was appointed Associate Professor of Visual Arts (with tenure). Visiting Professors included Dimitris Antonakakis in architectural design, and Alex Tzonis and Robert van Pelt in history, theory, and criticism. Visiting Associate Professors were Bill Hubbard, Jr., Hasan-Uddin Khan, Terry Knight, Charles Rose, Paul Donnelly, and Peter Testa. Testa's appointment as Associate Professor of Architecture becomes effective July 1, 1997. Lecturers were appointed to cover subjects normally taught by faculty on leave or to meet a perceived need for specific skills or topics: Carl Fasano, Paul Paturzo, Yule Heibel, Vincent Cammalleri, Juan Pedro Paniagua, Barry Webb. Howard Burns and Daniel Tsai collaborated with William Mitchell in a computational studio teaching project.

Edward Levine and Julian Beinart took leaves in the fall term; Nasser Rabbat, Leslie Norford, Ellen Dunham-Jones, and Leila Kinney in the spring.

Maurice Smith and John Myer, two professors who long gave distinctive shape to the studio program, completed their terms of appointment.

The Department of Architecture lost a valued colleague with the death of Wade Hokoda, director of Computer Resources. The History, Theory, and Criticism section mourns the death of Ernest Pascucci, PhD candidate. Professor Emeritus Herbert Beckwith died in June.

Searches are ongoing for a senior design position and a tenure-track position in building technology. A video lecturer search resulted in the appointment of Julia Scher, effective 1 July 1997.

DEPARTMENT ACTIVITIES

The Department of Architecture Lecture Series brings outstanding scholars, practitioners, and artists to the School. In the fall, speakers were Ann Pendleton-Jullian, Alex Tzonis and Liane Lefaivre, Tod Williams, Lionel March, Gunter Henn. In the spring, speakers included August Sarnitz, Laurie Olin, Lawrence Weiner, Anne-Catrin Schultz, Joseph Brown, Micha Bandini, Michael Pyatok. The Arthur H. Schein Memorial Lecture was given by Ada Karmi-Melamede. The Pietro Belluschi Lecture was given by N. Michael McKinnell. The Department was further enriched by the Building Technology Lecture Series, the HTC Forum, and the Friday Noon Lectures. A faculty-to-faculty forum was initiated this year, to introduce faculty to each other's work in research and in practice, and to offer opportunity for exchange of talents and interests among them.

A student-initiated exhibit of studio work appeared in the Wolk Gallery and featured computer-manipulated and traditional means of representation. Graduate students created the computer-based imagery for another Wolk exhibit on "The Middle Passage," a joint project by a local artist and architect. Work by Dimitris Antonakakis appeared in the soon-to-be redesigned Fourth Floor exhibition space. Two students won a design competition sponsored by the

Dean's Office to create flexible exhibition space outside the renovated studios. They will build their winning project this summer. Students in Maurice Smith's workshop installed a "built collage" outside the cafe to celebrate his teachings.

The department publication, *Thresholds*, is now well established as a means to communicate to alumni and friends of the School something of the intellectual life here. The weekly newsletter, *PinUp*, served to communicate within the department the many activities available to students, faculty and staff. In particular this year, photo spreads featured studio work.

Attilio Petruccioli organized not one but two international conferences in the fall: "Urban Triumph or Urban Disaster? Post-War Construction" and "Bukhara: The Myth, the Source, the Architecture, and the Urban Fabric." In the spring he organized a conference on "Courtyard House and Urban Fabric." Andrew Scott organized a major fall symposium on "Dimensions of Sustainability," focusing on the relationship of environmentally responsive architecture to questions of form, technology, environment, and culture.

Research in all discipline groups continues to yield opportunities for students in studio and thesis work and to earn recognition for the department. In addition to the prestigious Edgerton Award, Julie Dorsey received major grants, including a multi-year NSF grant, to continue her research in visualization. She also won a prestigious Architectural Research Award from *Architecture* and the AIA. Qingyan Chen and Leon Glicksman received recognition from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers with a major grant. Chen also received a multi-year NSF grant. Chris Luebke received a grant from the Class of '51 Fund for Excellence in Education and the Class of '55 Fund for Excellence in Teaching. Ann Pendleton-Jullian's book, *The road that is not a road*, was published by The MIT Press. She was named the inaugural holder of the Alfred Henry and Jean Morrison Hayes Career Development Chair. A celebration and symposium in honor of Stanford Anderson marked the publication by The MIT Press of *The Education of an Architect* (M. Pollak, ed.), a collection of essays by his colleagues and former students in the history, theory, and criticism of architecture. Dennis Adams, Krzysztof Wodiczko, Ritsuko Taho, and Barbara Broughel received public art commissions. Fernando Domeyko won a design competition for a church in Chile, now under construction.

I would assess the events of the past year as a rather steady state, but there was significant planning for future development in undergraduate teaching, sustainability, landscape, preservation, computation, and indoor air quality.

Stanford Anderson

PROGRAM IN MEDIA ARTS AND SCIENCES

For the 1996-97 academic year, the Program in Media Arts and Sciences (MAS) enrolled 111 graduate students. In addition, more than 200 undergraduates registered in Media Arts and Sciences classes or actively engaged in research activities at the Media Laboratory.

During the year, we continued to explore several options that would enable us to expand the scope of our undergraduate educational program. We are working with other departments (most notably Mathematics, Physics, and Chemistry) to find a mutually agreeable way for Media Arts and Sciences to offer an experimental freshman program. Our hope is that this effort will be a first step toward instituting a Media Arts and Sciences undergraduate program sometime in the near future.

EDUCATION

The Program in Media Arts and Sciences received 205 applications during the 1996-97 academic year. From these, 42 new students (including 9 women) were selected and enrolled: 36 for the master's program, and 8 for the doctoral program. This represented a 56 percent increase over fall 1995 admissions.

The total MAS enrollment of 111 included 23 women, 3 underrepresented minorities, and 28 foreign students. Of the total, 58 were master's candidates, and 53 were doctoral candidates. Thirty-one advanced degrees were awarded during the year (23 SMs and 8 PhDs). Thirty-five graduate subjects were offered.

For 1996-97 we offered nine undergraduate subjects. In addition, five Media Arts and Sciences faculty members and staff conducted freshman seminars or served as freshman advisors. The largest undergraduate presence at the Media Laboratory continued to be UROP students. More than 240 undergraduates participated in UROP research projects at the Laboratory. Many of these undergraduates pursued their undergraduate theses under MAS faculty supervision.

FACULTY AND STAFF

Bruce Blumberg, who recently completed his PhD with Pattie Maes in the Laboratory's Autonomous Agents group, joined the Media Arts and Sciences faculty as an assistant professor in October 1996. Previously, Professor Blumberg held positions at Apple Computer, Inc., where he was product manager for the original Apple Laser Writer, and NeXT, Inc.

Assistant Professor Bruce Blumberg was named the Asahi Broadcasting Corporation Career Development Professor of Media Arts and Sciences. Professor Blumberg, whose research focuses on creating lifelike virtual creatures, is one of the chief architects of the Media Laboratory's ALIVE project, and creator of Silas T. Dog, the Laboratory's favorite virtual pet.

Assistant Professor Justine Cassell, head of the Media Laboratory's Gesture and Narrative Language group, has been named the first AT&T Career Development Professor of Media Arts & Sciences. Professor Cassell's research focuses on endowing "things" with social and communication skills. Specifically, she studies how artifacts such as interface agents and toys can be designed with psychosocial competencies, based on a deep understanding of human linguistic, cognitive, and social abilities.

HONORS AND AWARDS FOR FACULTY AND STUDENTS

Professor John Maeda was awarded the 1996-97 Tokyo Type Director's Club Gold Prize for 10 Morisawa Posters exhibited at the Ginza Graphic Gallery in August 1996. Professor Maeda explores the relationship between visual form and various sensing media in order to develop a reliable means for creating computer-human interfaces that not only communicate, but are also aesthetically engaging.

Professor Pattie Maes, a pioneer in software agent development, was named one of the 1997 "100 Global Leaders of Tomorrow" by the World Economic Forum.

Seymour Papert, LEGO Professor of Learning Research Emeritus, was named the winner of this year's NEC Leadership Award for Education by the Smithsonian Institution. He was cited as "an outstanding model for young people who are eager to learn how to contribute to their society."

OTHER NEWSWORTHY EVENTS

Professor Seymour Papert published a new book, *The Connected Family: Bridging the Digital Generation Gap* (Longstreet Press, 1996).

Professor Tod Machover's latest CD, *Angels*, was released on the Erato/Warner label. This recording was a collaboration with Joel Cohen, a specialist in early music, and director of the Boston Camerata.

PhD candidate Paula Hooper, studying with Seymour Papert in the Laboratory's Epistemology and Learning group, was awarded one of six Warren Weaver Fellowships granted by the Rockefeller Foundation. She has been invited to join the foundation's School Reform Program during a one-year residency in New York City.

Jon Orwant, a PhD student in the Laboratory's News in the Future group, published *Perl 5 Interactive Course* (Waite Group Press, 1996). He also founded *Perl Journal*, a quarterly magazine devoted to the Perl programming language.

Bernd Schoner was awarded three top honors (the Henry Ford II Prize, the Springorum Medal, and the Otto Junker Prize) by the Rheinisch-Westfälische Technische Hochschule (RWTH) in Aachen, Germany. Schoner, who first came to the Media Laboratory as a visiting student from RWTH, is now a PhD candidate working with Professor Neil Gershenfeld in the Physics and Media group.

Michael Travers's 1996 PhD dissertation, "Programming with Agents: New Metaphors for Thinking about Computation," was one of two nominated by MIT for the Association for Computing Machinery's Doctoral Dissertation Award.

Alex Pentland

DEPARTMENT OF URBAN STUDIES AND PLANNING

The Department of Urban Studies and Planning (DUSP) continues to be the nation's leading school for professional education and scholarship on urban issues. Our focus this past year has been on maintaining this high level of academic excellence and positioning ourselves to remain on the cutting edge of scholarship and practice in the field. The Department of Urban Studies and Planning is considered by many to be ranked #1 among city/regional planning schools.

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: 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:

- Faculty and students of the Design and Development Group completed proposals for a new high-speed train station and associated development outside of Barcelona, Spain. The project was a collaboration with the School of Architecture of the Polytechnic University of Catalunya; seven students from Catalunya joined the project for a semester in Cambridge. Students and faculty of the group also completed research on developing a model planning program for urban harbors, a project sponsored by the Massachusetts Coastal Zone Management Office and the City of New Bedford (see student awards below). Continuing its collaborative program with the Department of Architecture, the group awarded nine Urban Design Certificates to graduating Master's students.
- The Environmental Policy Group (EPG) successfully launched its new Environmental Technology and Public Policy Program, with faculty and students generating almost two dozen working papers examining the ways in which regulatory strategies need to be changed to encourage greater investment in and sharing of technologies for pollution prevention, pollution control, and environmental remediation. More than a dozen students and six faculty participated. EPG faculty also participated actively in the work of the Alliance for Global Sustainability, the Program on Environmental Engineering Education and Research, the Provost's Council on the Environment, and other campus-wide initiatives in the environmental field.
- Framing an action research agenda to explore the impact of massive policy changes in federal housing and welfare policy at the neighborhood level in Boston stimulated much discussion at the Housing, Community, and Economic Development Tuesday luncheon series this spring. A proposed initiative emerging from these discussions will include work with the Washington-based Brookings Institution and its effort to monitor the front-line impact of housing and welfare "devolution." Student internships with Boston organizations involved with aspects of this transformation are to be part of the initiative as are weekly meetings of the group at MIT in the fall to share perspectives on what is happening in the neighborhoods as the policy changes play out institutionally.
- The role of decentralization in good governance is the central question of a new research initiative sponsored by the International Development and Regional Planning group and the United Nations Development Programme (UNDP). Students, with faculty supervision, are working in parallel with local institutions to carry out field work in Brazil, Columbia, Cote d'Ivoire, Honduras, India, Pakistan, the Philippines, Poland, South Africa, Thailand and Uganda. UNDP provides travel support and a stipend. The result will be a series of student reports and a book analyzing elements of "best practice" in administrative decentralization.
- Seed money from the Bemis Fund enabled the Planning Support Systems (PSS) group to leverage additional support from SSR Realty Advisors to compile "real-world" spatial data about Boston and utilize Geographic Information Systems (GIS) tools to analyze the data for non-profit community-based clients of the spring GIS Workshop class. With support from the Federal Geographic Data Committee and the cooperation of the State's MassGIS group, the PSS group developed and implemented an MIT Web browser for Boston-area digital orthophotos (aerial photos).

Faculty-led seminars and projects often cut across the different disciplines within the Department and provided some of the intellectual highlights of the year. A faculty colloquium in FY96 led to preparation this year of a new book, *High Technology and Low-Income Communities: Prospects for the Positive Use of Advanced Information Technology*, which is partially funded by the Kellogg Foundation and will be published by MIT Press in the fall. A joint weekly seminar series with the Lincoln Land Institute explored issues of Informal Land and Housing Markets. In the fall, first-year Master's students participated in three all-day seminars with panels of distinguished visiting faculty and professionals speaking on Stratification: Race, Class and Gender, Ethical Dilemmas in Planning Practice, and Critical Pragmatism and Planning Practice. In the spring, Ernesto J. Cortes, Jr., who will be joining the department in the fall as a Martin Luther King Visiting Professor, provided a lively warm-up for next year's classes by teaching a short course on community organizing.

GRADUATE DEGREE PROGRAM ENROLLMENT AND ACTIVITIES

Graduate program enrollment remained constant this year. Out of a total of 186 graduate students, 46% were women, 12% were students of color and 41% were international students. The Department granted 63 Master in City Planning (MCP), 1 SM and 5 Ph.D. degrees.

AWARDS

Our students received many Institute-wide awards. Both Carroll Wilson Awards went to DUSP students, Laura Fried and Heeten Kalan. Minakshi Mani received an Aga Khan Travel Grant. Ph.D. students who won awards through the Center for International Studies included International Energy and Environmental Policy Research Grants to Aniruddha Dasgupta, Granville Sewell and Anuradha Joshi, a Ford Development Grant to Nichola Lowe, and MacArthur Summer Research Fellowships to Octavio Damiani and Mona Mourshed. An International Motor Vehicle Program Research Grant was awarded to Sumila Gulyani. Adil Najam won the Goodwin Medal and was appointed to the MIT Society of Fellows for Sustainability. First Prize for the Harold and Arlene Schnitzer Prize in the Visual Arts went to Francisco Ortiz. Anthony Ives won the Karl Taylor Compton Prize and Michelle McDonough was elected Vice President of the Graduate School Council.

At the annual Commencement Breakfast, the Department presented a number of student awards. Amanda Bickel received the American Institute of Certified Planners Outstanding Student Award, as well as sharing the Flora Crockett Stephenson Writing Prize with Stephan Solzhenitsyn. The Outstanding Contribution to the Intellectual Life of the Department award went to Brian McLaughlin, with Honorable Mention to Chrystal Kornegay and Christian Willauer. Mark Norton won the Departmental Service Award; Susan Silberberg received Honorable Mention, as well as winning the Wallace, Floyd Award for City Design. A new award for Outstanding MCP Thesis was awarded to Debabrata Talukdar.

Outside of MIT, our students garnered local, national and international awards as well. Ximena Rueda won an Inter-American Foundation Fellowship. Adil Najam was awarded the Steein Rokkan Award for Young Scholars from the International Political Science Association. The Smithsonian Institution's Enid A. Haupt Fellowship in Horticulture went to Thomas Campanella. Genevieve Vachon received the Environmental Design Research Association Student Research Grant and Mona Mourshed won the Smithsonian Institution's Council of American Overseas Research Centers Fellowship. Paul Schimek got a US Department of Transportation Eisenhower Fellowship (1995-97) and received a Krambles Transit Scholarship. Alejandro Walters won a Social Sciences Research Council International Dissertation Research Fellowship and Monica Amorim received a Research Scholarship from the Northeast Development Bank in Brazil.

The American Planning Association awarded Fellowships to Susan Silberberg and Brian McLaughlin. The Massachusetts Chapter of the American Planning Association gave its Outstanding Planning/Student Project Award to Naomi Desta, Christina Gouveia, Tomoko Kodama, Makiko Takahashi (all MCP '96) for their East Acton (Massachusetts) Village Plan, completed for Lecturer Terry Szold's Community Growth and Land Use Planning class. Students of Senior Lecturer Dennis Frenchman took Honorable Mention for the American Institute of Certified Planners, Student Project Award for their New Bedford/Fairhaven Harbor (Massachusetts) Study (Matt Carpenter, Jose Lee Chibli, Raj Singh, Jim Vandermillen—all MCP '96). The Somerville Neighborhood Planning Committee gave its Distinguished Citizen Award to Kier Riemersma. Daniel Freire won the University of St. Gallen, Switzerland's 26th Management Symposium Essay Competition.

CURRICULUM UPDATE

Building on the success of the last couple of years, faculty continued to shift toward offering more 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, four additional for-credit courses were offered this year: Financing Infrastructure, Management Fundamentals for Leaders in Non-Profit Organizations, Neighborhoods and Networks in the Devolution Revolution, and Tagging: Public Graffiti or Private Art? These classes, combined with non-credit offerings, attracted over 300 students, alumni/ae and local professionals.

ALUMNI/AE NEWS

Our alumni/ae continued the trend of increasing generosity during the fall telethon. Thirteen callers contacted 170 alumni/ae, who had a pledge rate of 85% and a gift upgrade rate of 21%. Alumni/ae also gave generously of their time. In addition to guest appearances in classes and presentations at luncheon seminars, sponsoring student interns and participating in the annual "Chase-A-Planner" exercise, alumni/ae shared their wisdom at each of the Program groups' alumni/ae career panels, which received rave reviews by students. In addition, local alumni Joseph H. Brevard, III, MCP '71 and Edward Shoucair, MCP '84, hosted more than forty students at an open house at their planning firm. Many local alumni/ae joined us for a special dinner and lively discussion with Nobel Laureate Dr. Oscar Arias Sánchez (see below). Elisabeth Stock, MCP '95, was elected Young Graduate Member of the MIT Corporation.

UNDERGRADUATE PROGRAM ACTIVITIES

This past year, the Department's Undergraduate Committee focused its attention on finding ways to increase the visibility of our undergraduate program within the MIT community, while simultaneously consolidating subject offerings. Our plan is to propose a new interdisciplinary Minor in Public Policy, to be targeted to those with majors in science and engineering. This initiative will require the cooperation of the Political Science and Economics departments, among others, and it is our hope that consideration of the proposal by various MIT committees will occur during the 1997-98 academic year. In the meantime, overall Course XI subject enrollments and subject ratings seem to be solid and increasing, indicative of growing interest among MIT undergraduates in these issues. DUSP faculty once again led six very popular Freshman Advising Seminars. It is also worth noting that the Institute's new Freshman Leadership Program, developed by Course XI Concentrator Pardis Sabeti '97, was a direct outgrowth of a term paper produced for a DUSP course.

The MIT Teacher Education Program (TEP) has just completed its third full year. Over this period, 54 students have enrolled in 11.124, Introduction to Teaching and Learning Mathematics and Science, the initial course toward completing Massachusetts Teacher Certification. The first student completed certification requirements through TEP in June 1995 and in the last two years, 15 more students have completed certification and are now teaching in public middle or high schools, mostly in the Boston area. When working with a full staff, we expect to certify, on average, 10 students each year in math and science. In numbers, this will put us near the top in these fields among local teacher education programs. More information about this program can be found on the World Wide Web at the following URL: <http://web.mit.edu/teacher-ed/www/>.

FACULTY ACHIEVEMENTS

Several faculty were honored for their contributions to their respective fields. Professor Karen R. Polenske received the Walter Isard Distinguished Scholar Award by the North American Regional Science Association. The Massachusetts Chapter of the American Planning Association gave its Faye Seigfriedt Award to Lecturer Terry S. Szold for distinguished leadership and service in relation to contributions to the advancement of women in planning. Professor Joseph Ferreira, Jr. was elected president of the Urban and Regional Information Systems Association (URISA), the oldest professional organization in the US that is concerned with information systems in urban and regional planning. Professor Frank Levy's new book received extensive coverage by the national radio, television and print media, including an article in *Newsweek* in September. Levy's book, *Teaching the New Basic Skills*, co-authored with Harvard's Richard Murnane, takes a critical look at the skills taught to public school students versus those that are needed to do the jobs in today's economy. An October article in *Chemical Week* highlighted the "Chlorine Game," a simulation developed by a team led by Professor Lawrence E. Susskind, which uses role playing to teach international environmental diplomacy.

In faculty development, Associate Professor Lawrence J. Vale was granted tenure. Assistant Professor Qing Shen was appointed Mitsui Career Development Assistant Professor. The Department hired Jennifer Davis, Ph.D. in Environmental Engineering, from the University of North Carolina. Professor Davis will join the faculty as Assistant Professor of Infrastructure Planning in the fall of 1998. We are continuing the search for a new head for the Community Fellows Program, and have engaged the services of a national firm to assist in that search, as well as to identify a distinguished minority faculty member to join the Department as well.

In staff awards, Administrative Officer Rolf Engler's long years of service to the Department and MIT were honored with the receipt of the Gordon Y. Billard Award.

SPECIAL EVENTS AND PROGRAMS

The Department was honored to host this year's Karl Taylor Compton Lecture series by Dr. Oscar Arias Sánchez, Nobel Peace Laureate and former President of Costa Rica. Dr. Arias delivered three lectures on critical topics of our time: "Demilitarization: A Major Factor for Development," "Latin America Facing New Challenges," and "How Much Poverty Can Democracy Endure?"

The second year of the Planners' Forum, jointly sponsored by the Department and Massachusetts Chapter of the American Planning Association (APA), featured Peter Calthorpe, architect and author of *The Next American Metropolis*, who spoke on "Transit-Oriented Development: Making it Work" and Pat Clancy, Executive Director of the Community Builders, who spoke on "The Devolution Revolution: Affordable Housing and Its Future."

In November, The American Institute of Certified Planners, the Society for American City and Regional Planning History, and the Massachusetts Chapter of the APA presented the Department with a plaque honoring Frederick J. Adams as a "National Pioneer." Professor Adams was the founder of the Department and the first chair in 1933. The plaque is on display at the Department's Headquarters.

INTERNATIONAL CONNECTION

Our non-degree programs continued to enrich the life of the Department. The Special Program for Urban and Regional Studies (SPURS) hosted fourteen Fellows from Belgium, Brazil, Columbia, People's Republic of China, Poland, Sri Lanka, the Republic of Sakha in Russia, Saudi Arabia, Taiwan, Thailand, and Ukraine. The interests of the group were varied and diverse, ranging from environmental planning and urban design in Saudi Arabia to urban poverty and violence in Brazil to international finance and real estate development in China and transportation in Sri Lanka.

COMMUNITY OUTREACH

The domestic counterpart, the Community Fellows Program, brought 11 mid-career community activists from communities of color across the US to work on youth-oriented research projects supported principally through grants from the Ford and Kellogg Foundations. Individual research projects ranged from bringing advanced technology to a community college serving economically disadvantaged students in Puerto Rico to developing a volunteerism program for Native American youth in Wisconsin. A "Community Fellows Seminar Series" kicked off this year and brought scholars and activists to MIT to discuss social justice issues.

FUNDRAISING

Faculty raised over \$1.7 million in grants and contracts for the following research projects: Research Scientist Thomas Piper and Professor John de Monchaux, \$900,000 from a consortium of sponsors for "The Boston Conference: Harbor Town Meeting" to stimulate an interactive dialog on the future of the Boston Harbor, Boston and New England; Professor Judith Tandler, \$359,188 from the government of Brazil for a project to explore economic integration and regional development in Northeast Brazil; Professor Ferreira, \$263,567 from Aerodyne Research for a project using Geographic Information Systems to analyze "Urban Metabolism and Environmental Physics"; Professors Bish Sanyal and Paul Smoke, \$80,300 from the United Nations Development Programme for a study of decentralization in 11 countries; Professor Ferreira, \$50,000 for extension of the National Capital Planning Commission contract to explore and demonstrate urban environment simulations that can help understand security and proximity issues in planning of federal facilities; Professor Karen R. Polenske, \$28,112 from the National Science Foundation for a study on "Effects of Alternative Technologies on Energy and Pollution in China"; Senior Research Scientist/Lecturer Michael Shiffer, \$24,876 from the U.S. Department of Transportation for development

and optimization of networked multimedia representational aids to support transit-oriented environmental review activities; Professors Bish Sanyal and Omar Razzaz, \$19,300 from the Lincoln Institute for Land Policy for a research seminar on informal land and housing markets.

As part of an on-going effort to develop more individual donors to the Department, friends and current donors to the School joined us for a kick-off dinner in the fall with an engaging talk by benefactor Daniel Rose and an intimate dinner in the spring with Dr. Oscar Arias.

More information about the Department can be found on the World Wide Web at the following URL:
<http://sap.mit.edu>

Bish Sanyal

CENTER FOR ADVANCED VISUAL STUDIES

The Center for Advanced Visual Studies (CAVS) offers a teaching and research environment that fosters collaborations between artists, scientists, and technologists. These are typically built around art projects undertaken by resident Fellows, who also conduct seminars and supervise undergraduate participation. An emerging mission of the CAVS is the exploration of the digital arts as a common ground for large-scale collaborative projects.

Stephen A. Benton, E. Rudge ('48) and Nancy Allen Professor of Media Arts and Sciences, became Director of the CAVS on July 1, 1996, succeeding Prof. Krzysztof Wodiczko. Prof. Benton has been affiliated with the Center since 1977, and has collaborated with several Fellows in the area of holographic art. He also directs the Spatial Imaging Group at the Media Laboratory, and teaches in the Media Arts and Sciences academic program.

Planning for new quarters for the CAVS were undertaken with the advice of Centerbrook Architects and Planners, of Essex, Connecticut, and renovations have begun on the third floor of Building N52 for occupancy in Fall 1998. Comprehensive digital arts facilities will be installed there as a basis for new work at the Center.

An extensive collaboration with the *Instituto de Soldadura e Qualidade*, of Lisbon, Portugal, and conferences with present and former Fellows of the Center resulted in an extensive proposal to the management of Expo'98 (Lisbon) for a stand-alone public art exhibition for presentation next summer at Expo'98. The overall theme of Expo'98 is "Oceans, a heritage for the future," for which the CAVS is proposing an immersive computer-graphic display of "data art" relating to the oceans. Further development with the USIA (the USA pavilion management) and NASA (for satellite data visualization) is currently underway.

The Center was particularly well represented at the October, 1996, "Holographic Network" art & science conference at the Academie der Künste, Berlin, Germany, by invited presentations by Prof. Benton, Prof. Emeritus Piene (keynote lecturer), Senior Fellows Elizabeth Goldring and Paul Earls, and Affiliate Seth Riskin.

Activities of Fellows during 1996-97 included:

- Paul Earls was elected a Founding Board Member of the International Kepes Society at its First International Light Symposium, Eger, Hungary. Paul is now a Senior Fellow at the Center.
- Susan Gamble completed her work on holographic imaging of textual materials.
- Elizabeth Goldring's work on "visual poetry for the blind" continued in collaboration with Dr. Robert Webb of the Schepens Eye Research Institute, Boston. Ms. Goldring's work has been widely reported, on the "ABC Evening News" and the BBC "Tomorrow's World" programs for example. Elizabeth is now a Senior Fellow at the Center, and Head of its *Vision Arts Group*.
- Piotr Kowalski completed his "MIT<->Lyon Information Transcript Project," which provided instantaneously translated communication between the Lyon Art Biennale and MIT's Lobby 7 via the Internet.
- Professor Emeritus Otto Piene serves as Director Emeritus, and also as Secretary of the MIT Advisory Committee on Art, Science and Technology (with CAVS sponsorship). Prof. Piene's work is the subject of a major retrospective exhibition at the City Art Museum, Düsseldorf, Germany, that opened this year.
- Professor Krzysztof Wodiczko is now Head of the Center's *Interrogative Design Group*, and with Adam Whiton maintains a small studio within the Wiesner Building, where Media Lab students interact with the questions Prof. Wodiczko's work raises. In the Fall of 1996, Prof. Wodiczko presented "Projekcja Publiczna," a large-scale video projection on the tower of the Town Hall of Krakow, Poland.

Activities of Center Affiliates during 1996-97 included:

- Gloria Brown-Simmons organized a study of "creative visualization" as a tool to permit artists to use scientific data as a starting point for aesthetic explorations.
- Robert Dell installed his unique geothermal sculpture "Reykjavik/MIT/Yellowstone" in the Kresge Oval this Spring.

More information about the CAVS can be found on the World Wide Web at this URL: <http://web.mit.edu/mit-cavs/www/>

Stephen A. Benton

AGA KHAN PROGRAM FOR ISLAMIC ARCHITECTURE

In 1979 the Aga Khan Program for Islamic Architecture (AKPIA) was established as a joint MIT/Harvard University program through the generous support of His Highness, the Aga Khan. The AKPIA is dedicated to the research and teaching of architecture and urbanism in countries with Islamic cultures. Endowed program funds and annual funds from the Aga Khan Trust for Culture provide support for faculty, student financial aid, library facilities, research, teaching projects, conference activities, fieldwork, publications, and outreach to a network of institutions and people in the field of architecture and urbanism. AKPIA teaching and research spans a broad geographical range: from Southern Europe and North Africa to Southeast Asia, as well as a broad historical range including the pre-classical antecedents of Islamic architecture through its historical development in the Mediterranean Basin, the Middle East, and Asia into the Modern Period.

The central administration office, located at MIT, coordinates AKPIA activities, at both MIT and Harvard University, and maintains exchanges of fiscal and substantive information with the donor, the Aga Khan Trust for Culture in Geneva. During the 1996-97 academic year the MIT office continued its communications and outreach work for the program. Internal coordination of student, faculty, visiting scholars, and staff activities was carried out under the supervision of the Acting Director and Aga Khan Professor Attilio Petruccioli.

ACTIVITIES

The 1996-1997 MIT lecture series was organized by Professor Attilio Petruccioli. The fall series included talks by Andre Raymond, University Aix-en-Provence; Susan Miller, Harvard University; and Maurice Cerasi, University of Genoa. The spring series included talks by Mauro Bertagnin, University of Udine; Aleksandr Naymark, Indiana University; Eugenio Galdieri, University of Rome; Renata Holod, University of Pennsylvania; Maurizio Tosi, University of Bologna; and Ebba Koch, Art Historian. Lectures were also given by AKPIA Visiting Scholar Shakeel Hossain and former Visiting Scholar Amir Pasic.

Organized by Rotch Visual Collection Librarian, Ahmed Nabal, the AKPIA exhibition, "The Aga Khan Awards for Architecture: Selection of Seven Projects from the Sixth Award Cycle (1992-1995)." was displayed at MIT from September through December 1996.

In November 1996 "Ritual Architecture and Urbanity: The Ephemeral, the Transient, the Static," an exhibit curated by AKPIA Visiting Scholar Shakeel Hossain, arrived at MIT from its Spring 1996 debut at the Milan Triennial 19th International Exposition. This exhibit of ritual structures and photographs from India, was shown at the MIT Wolk Gallery and Rotch Library through February 1997. This project, funded by the AKPIA and the New Delhi National Trust for Art and Cultural Heritage, is traveling to the University of Pennsylvania in September 1997.

Visiting Associate Professor Hassan-Uddin Khan coordinated and co-curated "Modernities and Memories: Recent Works from the Islamic World" which opened at the Venice Biennale in June 1997. The first BV entry of its kind, artists of Islamic milieu from Canada to Indonesia exhibited recent works contributing, through contemporary artistic expression, to a formidable dialogue concerning cultural identity and pluralism. This event received its primary support from the Rockefeller Foundation. Organizers are investigating a number North American and international venues as possible exhibition sites for these works.

Harvard Aga Khan Professor Gülru Necipoglu, in collaboration with Barry Wood, developed the Sackler Museum exhibit "Sewn Together by Peace of Mind: Islamic Album Pages from Harvard's Collections," which ran from March to June 1997.

Three international conferences and a roundtable discussion were held during the academic year. In October 1996 Attilio Petruccioli and Associate AKPIA Professor Nasser Rabbat organized the roundtable discussion, "From Antiquity to Islam in the Cities of al-Andalus and al-Mashriq." Hugh Kennedy from the University of Saint Andrews was key speaker. The event brought architectural historians, archaeologists, architects, and urban planners together to discuss the historical crosscurrents of Syrian and Spanish cities from Roman incorporation through later Islamic periods of development.

The first AKPIA international conference of the academic year, "Urban Triumph or Urban Disaster? Dilemmas of Contemporary Post-War Reconstruction," was held in September 1996 and organized by Jon Calame and Esther Charlesworth. This symposium received financial support from the Kress Foundation and the Trust for Mutual Understanding. This event stimulated post-conference dialogues resulting in a pilot Sarajevo fieldwork project addressing issues of post-war reconstruction.

"Bukhara: The Source, the Myth, the Architecture and the Urban Fabric," was held in November 1996 and was organized by Attilio Petruccioli to allow scholars from the Uzbekistan Republic to discuss their work with colleagues from around the world. Financial support was provided by the Kress and Graham foundations.

Organized by Attilio Petruccioli in April 1997 the AKPIA international symposium, "The Courtyard House and Urban Fabric," drew together 13 invited lecturers and 16 discussion participants from around the world. This conference covered issues of development and transformation of the courtyard house type, its relationship to change in urban fabric, its application as a typological form, and its relevance to contemporary design.

Harvard University Aga Khan Professor Gülru Necipoglu sponsored a number of speakers for the "Friends of Islamic Art Lecture Series." Post-doctoral Research Fellows who contributed lectures in their areas of specialization were Omur Bakirer, Inci Aslanoglu, Tulay Artan, and Barry Flood. This series also included the following distinguished speakers: Marianne Barrucand (University of Paris-Sorbonne), Priscilla Soucek (NYU-Institute of Fine Arts), and Reza Sheikh (Director, City Photography Museum of Tehran).

During June 1996, Professor Petruccioli conducted a fieldwork project with MIT students on the walled towns of Como, Italy and Essaouira, Morocco. This study was integral to the preparation of a studio workshop concerning the historical contexts of urban situations for the Fall 1996 semester.

In January 1997 the AKPIA conducted fieldwork in Bukhara, Uzbekistan. Attilio Petruccioli and MIT students traveled to Uzbekistan for a study financed jointly by the Kress Foundation and the AKPIA. This research concerned the development of an atlas comprising built forms and construction techniques in Bukhara.

Students with summer 1997 AKPIA travel grants are conducting individual research Bosnia-Herzegovina, Jordan, Morocco, Russia, Tunisia, and Turkey.

FACULTY AND STAFF

The AKPIA Committee, charged with policy decisions included: Stanford Anderson, Head, Department of Architecture, MIT (AKPIA Chair); William A. Graham, Director, Center for Middle Eastern Studies, Harvard; Philip S. Khoury, Dean, School of Humanities and Social Sciences, MIT; William Mitchell, Dean, School of Architecture and Planning, MIT; Gülru Necipoglu, Aga Khan Professor, Harvard; Attilio Petruccioli, Aga Khan Professor and AKPIA Acting Director, MIT; William L. Porter, Leventhal Professor of Architecture and Planning, MIT; Nasser Rabbat, Aga Khan Development Professor, History Theory and Criticism Program, Department of Architecture, MIT; Andras Riedlmayer, Aga Khan Program Bibliographer, Fine Arts Library, Harvard; David Roxburgh, Assistant Professor of Fine Arts, Harvard; Merrill Smith, Associate Rotch Librarian, MIT; Irene Winter, Chair, Department of Fine Arts, Harvard; and Christoph Wolff, Dean, Graduate School of Arts and Sciences, Harvard.

Attilio Petruccioli is the MIT Aga Khan Professor and Acting Director of the Program. Robert Marlatt is charged with AKPIA fiscal operations as senior staff assistant. Dina Freedman continued as part-time senior secretary through June 1997. Alberto Balestrieri was appointed as Assistant to the Director in May 1997.

ACADEMIC PROGRAMS AT MIT

In 1996-97, four AKPIA students participated in the Concentration in Architectural Studies of the Islamic World component of the Master of Science in Architecture Studies (SMArchS) degree program: Zarminae Ansari, Minakshi Mani, Yonca Kosebay and Georgiy Levashov. Tuition and living expenses for the SMArchS students at MIT were funded in whole or in part by AKPIA funds. Zarminae Ansari graduated in May 1997.

Student reflection and debate focused on both practical and theoretical issues concerning the architectural characteristics of non-western societies. Students were encouraged to compare traditional Islamic architectural forms and structures with those developed after the spread and application of Western ideas in modern times. They considered appropriate responses to climate, building materials, and building technology as well as the socio-cultural attitudes and values that directly relate inhabitants to their environment.

In the fall semester, students participated in a level III architectural design studio, "Architectural Design Studio: Islamic Societies: Como and Essaouira-A Center of Learning," led by Professor Petruccioli. This course compared old and new in the old walled cities of Essaouira (Morocco) and Como (Italy). Professor Petruccioli also taught the design workshop, "Architecture and the Urban Context: Traditions, Conflicts and Change: Typological Process and Built Form." This method and theory oriented course introduced students to more advanced architectural, urban and, territorial concepts of typological forms. In the spring Professor Petruccioli conducted two workshops. The first, "Special Problems in Non-Western Architecture: Form and Culture of Indian Cities," was co-taught with Visiting Scholar Shakeel Hossain; and, the second, "Architectural Design Workshop: Bukhara: The Language of Masonry and Vault Systems" served as further preparation for continued fieldwork in Uzbekistan.

AKPIA doctoral students in the History, Theory and Criticism Program (HTC) were: Lara Tohme, Kishwar Rizvi, Pani Pyla, Maha Yahya, Shrinie Hamadeh and Iffet Orbay. Tuition and living expenses for the Cambridge residential doctoral students at MIT were funded in whole or part by the AKPIA endowed scholarship fund.

Nasser Rabbat, Assistant Professor in History of Islamic Architecture, was awarded a Fellowship to the Institute of Advanced Study, Princeton, Spring 1997.

During the fall of 1996, Assistant Professor Sibel Bozdogan co-taught, with Nasser Rabbat, "The Making of the Discourse on Islamic Architecture." In the spring she taught: "1650 to the Present: Architecture and Post-Colonial Identity."

VISITING SCHOLARS

During 1996-97, the AKPIA hosted two visiting scholars. Khalil Pirani's research on Mosque architecture in North America was funded by the American Institute of Architects. Shakeel Hossain continued his work on his Ta'zia project, traveling to India, the 19th Milan Triennial International Exhibition, and MIT with his exhibit "Ritual Architecture and Urbanity."

LIBRARY RESOURCES AND PUBLICATIONS

Endowed AKPIA funds allowed the Rotch Architecture Library to acquire over 500 new titles for its collection. The Rotch Visual Collections (RVC) continued to provide reference and informational assistance to patrons throughout the world. The AKPIA librarians, Omar Khalidi and Ahmed Nabal, published "Library Materials Acquired 1993-96" a bibliographical synopsis and guide to AKPIA resource acquisitions. They also designed and implemented an important RVC website that includes links to textual and visual resources on Islamic architecture at MIT. Now available on line are "World-Wide Tour Of Islamic Monuments" and "Designed Mosques in the United States." Omar Khalidi and Ahmed Nabal presented their paper "Science and Islam," in Kuala Lumpur and visited Aga Khan Trust for Culture Headquarters in Geneva.

AKPIA Harvard Fine Arts Library colleagues Jeffrey Spurr and András Reidlmayer have been active in the review and management of the Harvard Semitic Museum Photographic Archives. They assisted the Brooklyn Museum, University of Nebraska, and to the Aga Khan Trust for Culture Library in Geneva with classification and technical projects. In addition to procuring acquisitions, organizing small exhibits, and soliciting new, private donations they initiated a post-war restoration project with the National and University Library of Bosnia and Herzegovina in Sarajevo. They are working with Attilio Petruccioli and the MIT Department of Architecture to seek underwriting for this project and to develop an exchange program with partner institutions in Sarajevo.

Attilio Petruccioli

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-five members of the twelfth class of MIT/CRE graduates received their SM degrees in Real Estate Development in September, 1996. Another student completed his thesis and received his degree in February, 1997. The 33 members of the incoming Class of 1998, which includes three joint degree candidates, were selected from a somewhat smaller than usual although still strong applicant pool in March. The new class of ten women and 23 men includes four international students and two others who have worked abroad for significant lengths of time. Although the average age of class members is still 29 years, the class is more experienced than usual, with nine members who have ten or more years experience in one or another aspect of the real estate industry.

Although there were no major changes to core courses this year, course content continues to evolve as the real estate industry changes. For example, the reader for course 11.432 Real Estate Capital Markets, taught by Assistant Professor Timothy J. Riddiough, has been almost completely revised each of the three years since the course was established as the role of the public markets in providing capital to real estate becomes more established.

RESEARCH

The Center hosted two visiting scholars this year. Professor of Real Estate Finance, Dennis Capozza, on sabbatical from the University of Michigan School of Business, spent six weeks at the Center during the fall term. He presented his recent work on the value of focus in real estate enterprises in a seminar for faculty and graduate students at the end of October. Henry Pollakowski, a housing economist and editor of the *Journal of Housing Economics*, has been in residence since September. His research on the effects of rent decontrol in New York City and the Boston area provided material for a cover story in the *New York Times* Sunday magazine in June. The findings of the New York research are published as a Center working paper.

The Center published three working papers, all co-authored by Assistant Professor Riddiough, in addition to the one mentioned above by Professor Pollakowski. Professor Riddiough's work focused on various aspects of commercial mortgage backed securities. One paper concerned the impact on retail centers of financing debt through the public markets; a second study compared the risks associated with real estate debt securities and bonds; and a third investigated the effects of a lack of reliable asset price information on the trading of real estate debt securities.

Sandra Lambert, a Lecturer in the Department of Urban Studies and Planning continues her research on the management of corporate real estate. Two reports are due out later this year: one on how leading real estate practitioners are providing corporate real estate services; and another on how companies surmount the challenges of managing real estate globally. Both reports are co-authored by Jean Poteete, a graduate of the MSRED program. The "CRE 2000" project is sponsored by the Industrial Development Research Council and Foundation.

PROFESSIONAL EDUCATION

The twelfth summer of professional development courses brought more than 400 attendees to campus in June and July of 1996, a slight increase over the previous summer. Four of the seven courses were filled to capacity and had wait lists. A new course on due diligence and building systems, presented by John Macomber, Lecturer in the Department of Civil and Environmental Engineering, was particularly in demand. Demand for the Center's 1997 Summer Institute courses continues strong. Enrollment by the end of June equaled total enrollment for 1996. The center scheduled an extra section of Fundamentals of Real Estate Finance, taught by W. Tod McGrath, Lecturer in

the Department of Urban Studies and Planning, to run in August to accommodate the overflow. That course has been a staple offering which increases in popularity when the real estate cycle is in the ascendant, as now.

MEMBERSHIP

Income from membership held virtually steady as the center closed the year with 80 supporting members (including ten international members). With leadership from Blake Eagle, Chairman, the center added 12 new members but lost 20 as the ten Epoch Foundation firms (Taiwan-based corporations with real estate interests who had joined the center via the ILP) withdrew from membership. In addition to annual fees, many members supported the center in non-financial ways by providing case study sites, lecturing in classes and in the Lunchbox Lecture series, and supporting student thesis work. This year, Robert Danziger, retiring Chairman of Northland Development, organized and led a well-received occasional seminar called Real Deals, in which guest speakers dissected a specific real estate transaction at length.

The center hosted two members' meetings. The November meeting on "Technology and the Future of Real Estate" featured Brandeis Associate Professor of Economics Adam Jaffe discussing the association of technology and economic growth based on his ground breaking research tracking the location of patent applicants and start-up firms. The morning program included an all-MIT roster of presenters who looked twenty years down the road and, based on their current research, projected likely developments in the areas of computers and telecommunications, building technology, logistics and inventory management, and organizational structure, all topics of some interest to the real estate industry as it thinks about space needs in the future. The May meeting focused on the hot topic of the securitization of real estate assets and asked the question, "Are the Public Markets Winning the Capital Race?" The evening speaker, G.Y. Billard Professor of Finance Stewart C. Myers, explained his theory of why companies go public and opined that it probably didn't make sense for much real estate to be publicly held. The morning speakers all opted for the alternate position, holding for a variety of reasons, that securitization, whether as equity or debt, was a growing and logical trend for real estate assets. Three of the speakers were from the securities industry, all of them leaders in the development of the new real estate equity and debt instruments. The fourth speaker, Assistant Professor Riddiough, cautioned that what makes sense in a growth cycle may have serious flaws in a real estate contraction, though he too believes the public markets will continue to be a growing source of capital for the industry.

ADMINISTRATION

Patricia Brady, MIT MSRED '88, Associate Director of the Center, accepted a position as Team Leader for MIT's Human Resource Practices Reengineering Team, in March. She had been working with the team on a part-time basis throughout the year. Her successor as Associate Director is Kathleen C. MacNeil, also MIT MSRED '88. Ms. MacNeil was formerly a project manager for Macomber Development Associates and for the Massachusetts Water Resources Authority. She is responsible for operations of the center, career services, and alumni relations.

Information about center programs and activities is published on the Web (<http://web.mit.edu/cre/www/>). This is a growing source of inquiries from the public about the MSRED program, professional development courses, and working papers.

William C. Wheaton

MEDIA LABORATORY

Even five years ago, few people could have imagined how quickly and thoroughly bits would pervade our everyday lives. Working parents are now grocery shopping on the Internet, neighborhood appliance stores are selling Web TV to 70-year-old retirees, and kids everywhere are using computers to discover exciting worlds beyond their own backyards, schools, or even continents.

Since its founding in 1985, the Media Laboratory has helped pioneer a vision of this digital society. Now, as we see this society taking shape, we're continuing to look for new ideas that are as outrageous in 1997 as the concept of a cellular phone in every pocket was in the mid-80s. This new work ranges from the development of electronic paper, which may lead to the world's first single-volume library; to quantum computing; to a system that uses our bodies as a communications channel, allowing digital information to be exchanged with a mere handshake.

To position the Laboratory for the next millennium, we have engaged in two important initiatives during the past year. The first is the creation of a new consortium, Digital Life, which will address the interconnection between bits, people, and things in an online world, from back-pocket PCs that listen to our stories when we're alone on the road, to tools for creating communities that span the globe. The second is a joint effort between the Media Laboratory and the newly formed 2B1 Foundation to ensure that developments from the Media Lab and other innovative educators around the world can help connect children from all cultures—closing the growing chasm between digital "haves" and "have-nots."

RESEARCH ACHIEVEMENTS

A sampling of 1996-97 Media Laboratory research accomplishments include:

- *Wearable computing*, where we move beyond PCs and laptops, and wear our computers as we would eyeglasses or clothing. The user can have augmented memory, where "to do" lists flash before his or her eyes; or where online information—even an entire book—can be displayed on demand.
- An entirely new approach to *quantum computing*. This work opens up the possibility that an ordinary liquid—like a cup of coffee—could harness natural forces so effectively that it would turn today's largest supercomputer into a digital dinosaur.
- *The Brain Opera*, which premiered at the 1996 Lincoln Center Festival, and has been performed around the world. This highly interactive musical event is based on the ideas put forth in Marvin Minsky's seminal work *The Society of Mind*. It draws audiences into the mysteries of how sensory perception, musical structure, language, and emotion can interplay to make music in a wholly new and original way.
- More effective, meaningful *online news services*. These range from the *Silver Stringers* project, where an online newspaper is created and run by senior citizens, to *The Daily Catch*, a prototype online newspaper that utilizes natural language understanding to develop more human-like understanding of content.
- *Field-sensing devices*. For example, a device now under commercial development by a Laboratory sponsor can be embedded in a car's seat to distinguish between a rear-facing or forward-facing baby, and can signal an airbag when—and when not—to explode.
- *Perceptual audio models*, which may revolutionize the future of sound design. Synthetic sound effects replace the sound designer and sample library with a single computer program capable of generating high-quality sound effects, similar to those used in films, but with more flexibility and much less effort.
- 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.

-
- Development of a new generation of *Toys To Think With*, including "Bitball" and "Programmable Beads," which can help kids learn new concepts such as process, communication, and probability, that were seen as too complex for kids in the pre-digital era.
 - *Intelligent agents* that perform tasks ranging from buying or selling your goods on the Internet, to finding groups with common interests, to continuously and unobtrusively searching your notes and electronic files for references to whatever you are currently reading or writing on your computer.
 - Systems for *device-to-device communication*, which allow everyday objects to become invisibly woven into a global digital fabric.
 - *Smart Rooms*, which act like invisible butlers. Using cameras, microphones, and other sensors, these rooms try to interpret what people are doing in order to help them.
 - New systems for *digital storytelling*, where a viewer can explore an evolving Web-based documentary.
 - Creation of a *multi-modal computer character* capable of face-to-face interactions with people in real time, perceiving their gesture, speech, and gaze.
 - *Echo data hiding*, where data are embedded into a host audio signal by the introduction of an "echo" that is perceived only as added resonance, or richness, to the human ear, but provides a hidden audio copyright tag—one that will stay with the signal even after editing or compression.
 - An *Audio Notebook*, which uses sensors to synchronize your note-taking with an audio recording of the speaker. Touch your pen to a specific word in your notes, and the recording will start playing back from that very spot.

SPONSORS

The Laboratory's research volume grew to \$13.6 million in Fiscal Year 1997, a 17 percent increase over the past fiscal year. Of this amount, \$12.3 million (90 percent) came from corporate sponsors. Approximately \$1.3 million (10 percent) came from the U.S. federal government (Department of the Army, DOT, NEA, NSF, and Office of Naval Research.).

New directed research sponsors during Fiscal Year 1997 included: Deutsche Telekom Berkom GMBH, which provided funding to Professor Justine Cassell for "Multimodal Communicating Interface Agents"; National Science Foundation, which provided a grant to Professor Mitchel Resnick for "Beyond Black Boxes: Bringing Transparency and Aesthetics Back to Scientific Instruments"; National Science Foundation, which provided a grant to Professor Justine Cassell for "Stimulate: A Unified Framework for Multimodal Conversational Behaviors in Interactive Humanoid Agents"; and University of California, Berkeley, which provided a grant to Professor Stephen Benton for "3-D Interfaces: An Interdisciplinary Pipeline."

In Fiscal Year 1997 the Media Laboratory initiated a new consortium: Digital Life (DL). Officially inaugurated on January 1, 1997, Digital Life explores ever-present, personalized networking and the attachments to it that enrich our creative lives. DL abandons the uni-directional nature of home entertainment and allows consumers of mass media to share in its creation. Technologies will target the full population of a globally interconnected society, from children to the elderly, and skateboarders to couch potatoes.

The DL program targets five areas: Evening of the Future, Digitized Devices, Face to Face Computing, Communities³ and the Infinite Internet. DL's program director is Andrew Lippman. Other faculty members and research staff involved with the consortium include: Stephen Benton, Bruce Blumberg, Aaron Bobick, V. Michael Bove, Jr., Justine Cassell, Glorianna Davenport, Judith Donath, Henry Holtzman, Hiroshi Ishii, Henry Lieberman, Ron MacNeil, Patricia Maes, Mitchel Resnick, Christopher Schmandt, and Barry Vercoe.

As of June 30, 1997, the list of DL sponsoring companies is:

American International Group, Inc., Bell Canada, Bertelsmann AG/BMG Entertainment, Bonnier/Marieberg, Citibank N.A., Dentsu, Eastman Kodak, Ericsson, Fuji Xerox, Hakuhodo Incorporated, Hongkong Telecom, Hughes Electronics, Intel, Kodansha Ltd. Publishers, The LEGO Group, MediaOne, Merrill Lynch, 3M, NIKE, Inc., Nortel, NYNEX/Bell Atlantic, OMRON Corp., Panasonic Technologies, Inc., Perot Systems Corporation, Philip Morris Companies, Inc., Philips, Riverland, R.R. Donnelly & Sons Company, SAIC/Bellcore, SAP AG, Saritel S.p.A., Seiko Epson Corporation, SGS Thomson Microelectronics, Shingakusha, Siemens Nixdorf Information Systems, Southwestern Bell Technology Resources Inc., Tandem Computers, Inc., Tele Danmark, Telecom Finland, Ltd., Televisa s.a. de c.v., TOPPAN Printing Co., Ltd., U.S. Robotics Access Corporation, Viacom International, WPP Group plc, Xerox Corporation.

Seven new sponsors joined the Laboratory's Things That Think consortium in Fiscal Year 1997: Karstadt AG, MasterCard International, Swatch AG, Symbol Technologies, Trimble Navigation Limited, United Technologies Corporation, and Visa International.

Four new sponsors joined the Laboratory's News in the Future consortium in Fiscal Year 1997: Corporation for Public Broadcasting, Eastman Kodak, Johnson & Johnson, and Sun Microsystems.

AT&T continued to support the Laboratory through its Digital Media Research Fund. The following students were named AT&T Media Laboratory Fellows in the fall of 1996: Benjamin Denckla, Daniel Gruhl, Giri Iyengar, Deb Roy, and Lisa Stifelman.

Interval Research Corporation Fellows, named in the fall of 1996 were: Matt Antone, Andrew Dahley, Rehmi Post, Eric Scheirer, Arjan Schütte, and Wasiuddin Wahid.

The following students were named Motorola Fellows for this fiscal year: Kevin Brooks, Pascal Chesnais, Rich Fletcher, Teresa Marrin, Rob Poor, Joshua Smith, and Manish Tuteja.

Eastman Kodak Company selected Phillip Tionson as the 1996-98 Kodak Fellow.

Telecom Italia provided a grant to support five Media Laboratory Fellows: Amy Bruckman, Nelson Minar, Nick Montfort, Flavia Sparacino, and Alan Wexelblat.

Mitsubishi Electric Research Corporation began a new fellowship program, supporting three students: Michael Casey, Michael Johnson, and Brygg Ullmer.

IBM Corporation gave \$154,000 in RISC Systems, laptops, and desktop computers.

Hewlett-Packard Company gave three recipient-enhanced grants for a total of \$320,000.

Intel Corporation provided \$710,000 in PCs.

Mitsubishi Electric gave projectors and monitors valued at \$37,000.

AMP Incorporated gave \$300,000 in various types of equipment for the expansion of the fiber optic network.

Silicon Graphics gave a grant of equipment valued at a total of \$2,442,740.

Microsoft Corporation gave \$230,000 worth of software, training, and support.

PERSONNEL

Kathleen Shanaghan joined the Laboratory as executive assistant to Nicholas Negroponte in July 1996. Ms. Shanaghan came to the Laboratory from A.T. Kearney, Inc. Before working at A.T. Kearney, Ms. Shanaghan

worked in the Executive Office of the President, managing the facilities of the White House complex in Washington, D.C.

Sarah Brady joined the Laboratory as senior financial officer in November 1996. Ms. Brady came to the Laboratory from MIT's Telecommunications Department, where she was manager of administration and finance. Previously, Ms. Brady worked as a manager at Tufts University and as a budget officer and a finance administrator at MIT.

Elizabeth Yonda joined the Laboratory as intellectual property coordinator in September 1996. Betsy Chimento joined the Laboratory as part-time graphic designer in the Office of Communications and Sponsor Relations in January 1997.

Deborah Widener joined the Laboratory as executive coordinator to Andrew Lippman, associate director of the Media Laboratory, in January 1997. Julia Royall joined the Laboratory as project coordinator for the Digital Life Consortium in the Associate Director's Office in March 1997.

The Laboratory appointed three new research scientists during 1996-1997: Hong Tan joined the Laboratory as research scientist for a two-year temporary appointment in the Vision and Modeling group in September 1996. Thomas Nwodoh joined the Laboratory as research associate in the Spatial Imaging group in April 1997. Judith Donath joined the Laboratory for a one-year appointment as research scientist in the Digital Life Program in November 1996. Ms. Donath received her PhD from the Program in Media Arts and Sciences in 1997.

The Laboratory appointed three new technical staff members during 1996-97: William Glesnes joined as network engineer in December 1996; Matthew Trunnell joined as network/systems engineer in January 1997; and Demetrios Paneras joined as webmaster/database coordinator for a one-year appointment in April 1997.

Kishore Sakharkar from the University of Singapore was appointed as research affiliate for three months beginning on January 12, 1997.

The Laboratory appointed two visiting researchers from Intel Corporation: Ilan Shamir was appointed research affiliate for the period from July 23, 1996 to June 30, 1997, and John David Miller was appointed visiting scientist for the period from June 1, 1997 to August 31, 1997.

The Laboratory appointed three visiting researchers from BT Laboratories to positions as research affiliates: Marcus Smith, for the period September 28, 1996 to December 13, 1996; Simon Hovel for the period January 27, 1997 to March 24, 1997; and Ulises Ramos Sanchez, for the period May 17, 1997 to June 17, 1997.

Reiner Van Kleij from Exol SpA was appointed as visiting scientist for two months beginning on August 1, 1996.

Fred Martin was promoted to a temporary three-year appointment as research scientist on June 1, 1996. Dr. Martin received his PhD from the Program in Media Arts and Sciences in 1994, and following completion of his degree, joined the Program in Media Arts and Sciences as a postdoctoral fellow from 1994-96.

Lynn Hyams was promoted to personnel administrator in October 1996. Ms. Hyams previously worked as administrative coordinator of finance and administration in the Media Laboratory.

Nicholas Negroponte

MEDIA LABORATORY SPONSORS

The following list indicates Media Laboratory sponsors as of June 30, 1997.

RESEARCH CONTRACTS

BT
Central Intelligence Agency
Department of the Army
Department of Transportation
Deutsche Telekom Berkom GMBH
European Commission
Hewlett-Packard
Honda R&D Co., Ltd.
International Business Machines
Korea Institute of Science and Technology (KIST)
LEGO Futura ApS
Microsoft Corporation
National Endowment for the Arts
National Science Foundation
Office of Naval Research
Oki Advanced Products Division
Samsung Electronics Co., Ltd.
Texas Instruments, Inc.
University of California, Berkeley

RESEARCH CONSORTIA

Digital Life (DL)
American International Group, Inc.
Bell Canada
Bertelsmann AG/BMG Entertainment
Bonnier/Marieberg
Citibank N.A.
Dentsu
Eastman Kodak
Ericsson
Fuji Xerox
Hakuhodo Incorporated
Hongkong Telecom
Hughes Electronics
Intel
Kodansha Ltd., Publishers
The LEGO Group
MediaOne
Merrill Lynch
3M
NIKE, Inc.
Nortel
NYNEX/Bell Atlantic
OMRON Corp.
Panasonic Technologies, Inc.
Perot Systems Corporation
Philip Morris Companies, Inc.
Philips
Riverland
R.R. Donnelley & Sons Company
SAIC/Belcore
SAP AG
Sartel S. p. A.
Seiko Epson Corporation
SGS Thomson Microelectronics
Shingakusha
Siemens Nixdorf Information Systems
Southwestern Bell Technology Resources Inc.
Tandem Computers, Inc.
Tele Danmark
Telecom Finland, Ltd.
Televisa s.a. de c.v.
TOPPAN Printing Co., Ltd.
U.S. Robotics Access Corporation
Viacom International
WPP Group plc
Xerox Corporation

RESEARCH CONSORTIA (continued)

News in the Future (NiF)
Aamulehti Group, Ltd.
ABC, Inc.
Advance Publications, Inc.
BellSouth Enterprises, Inc.
The Chronicle Publishing Company
Corporation for Public Broadcasting
Eastman Kodak
Editoriale L'Espresso S.p.A.
Gannett Co., Inc.
Grupo Clarin
Grupo Estado
Hearst Corporation
International Business Machines
JCPenney
Johnson & Johnson
Lotus Development Corporation
McCann-Erickson Worldwide
NY Times/Globe
Sun Microsystems
Televisa s.a. de c.v.
Thomson Newspapers Corporation
Tribune Company

Things That Think (TTT)
American Greetings Corporation
AMP, Inc.
Analog Devices, Inc.
ASCII Corporation
AT&T Corp.
Becton Dickinson and Company
Brother Industries, Ltd.
Creative Technology, Ltd.
Deutsche Telekom AG
EDS
Federal Express Corporation
The Gillette Company
Hewlett-Packard Company
Interval Research Corporation
Karstadt AG
The LEGO Group
Levi Strauss & Co.
Lord Corporation
MasterCard International
Microsoft Corporation
Motorola, Inc.
National Semiconductor Corporation
Neurotec International Corporation
NIKE, Inc.
Nokia Corporation
Oki America, Inc.
The Procter & Gamble Company
SEGA of America, Inc.
Sensormatic Electronics Corp.
Siemens AG
Steelcase Inc.
Swatch AG
Symbol Technologies, Inc.
Telia Research AB
3Com Corporation
Trimble Navigation Limited
United Technologies Corporation
VISA International
Volvo
Walt Disney Imagineering
YAMAHA Corporation

RESEARCH CONSORTIA (continued)

Singapore Digital Media Consortium (SDMC)
Aztech Systems Ltd.
iMedia (S) Pte. Ltd.
IPC Corporation Ltd.
Institute of Microelectronics (IME)
Institute of Systems Science (ISS)
Information Technology Institute (ITI)
National Computer Board (NCB)

MEDIA TECHNOLOGY GROUP

Canon
Citicorp/TTI
Compaq Computer Corporation
Gemini Consulting
Nippon Columbia Co., Ltd.
SAIC
Scitex Corporation, Ltd.
J. Sainsbury plc

SPECIAL FUNDS

AMP, Inc.
ATR Media Integration & Communications Research Laboratories
AT&T Corp.
Bay Networks, Inc.
Digital Equipment Corporation
FORE Systems, Inc.
Hewlett-Packard
Interlego A/S
Interval Research Corporation
Mitsubishi Electric
Motorola, Inc.
NEC
Silicon Graphics, Inc.
Telecom Italia
Toshiba

Brain Opera
Ars Electronica Center
Calouste Gulbenkian Foundation
Kravis Center for the Performing Arts
Lincoln Center for the Performing Arts, Inc.
NTT Data

ENDOWMENT AND NAMING GRANTS

Rudge and Nancy Allen
Asahi Broadcasting Corporation
AT&T Corp.
Armand and Celeste Bartos
Alex Dreyfoos, Jr.
Fukutake Publishing
Interlego A/S
LG Electronics, Inc.
Misawa Homes
NEC
Schlumberger
Sony
Toshiba
Philippe Villers
Muriel R. Cooper Memorial Professorship
DDP Digital Publishing, Inc.
Origin/Media Lab BV
Sarah Dickinson Memorial Fund

SCHOOL OF ENGINEERING

The School of Engineering has continued to move forward with new initiatives to enhance its position as the premier academic center for education and research in engineering in the United States. The School is committed to moving forward on several fronts to redefine engineering education and to establish new areas of leadership in engineering education and research. These initiatives are critical for MIT's continued leadership of the engineering profession and for the vitality of the School and the Institute.

Three initiatives are emerging as the focus of the developing long-range plan of the School. They are the integration of information technology throughout the engineering disciplines; a new emphasis on integration and synthesis in engineering, especially in the context of large-scale engineering systems, and, finally, pioneering the development of the field of bioengineering, defined as the interface between modern biology and the traditional engineering disciplines.

Each of these initiatives will require an unprecedented level of cooperation across the traditional academic departments. Resources will need to be reallocated to these interfaces which otherwise would have gone to more traditional disciplinary interests. Also, our core academic values will have to be broadened further to give additional weight to integrative, interdisciplinary education and research activities. Each department in the School of Engineering is preparing a long-range plan to describe the directions of the department and its needed resources for the next 5-10 years. These plans will be synthesized into a school-wide plan with objectives for faculty hiring and other resource allocation. Faculty hiring is a critical issue because of the need to replace the 37 faculty who left in the fall of 1996 as a result of the special retirement program.

New administrative structures are being considered to accommodate these interdisciplinary interactions. A faculty committee chaired by Professor Robert C. Armstrong, Head of the Chemical Engineering Department, has been formed to consider the structure of a Division of Bioengineering, composed of School of Engineering faculty with joint appointments between bioengineering and other engineering departments. This structure was proposed for the organization of an initiative in engineering systems by a School Committee chaired by Professor Thomas Eagar, Head of the Department of Material Science and Engineering. Discussions of this initiative are underway.

The School of Engineering moved aggressively to decrease the fraction of faculty academic year salaries funded from research. In addition to the decrease in needed research support of salaries caused by the early retirement program, the School allocated a sizable fraction of our discretionary funds in order that all faculty in the School could be brought under a uniform cap for support from research. This plan for charging faculty salaries to research was put in place starting July 1, 1997 and should relax some of the increasing pressure on faculty for research support.

The interface between the School of Engineering and industry was enhanced significantly with the first full class (35 students) of the System Design and Management (SDM) program, which is joint with the Sloan School of Management. These students typically have 3-5 years of industrial experience; many will take subjects in SDM via distance education as part of their course of study. The School of Engineering also launched a new Master of Engineering Program in Logistics, sponsored by the Center for Transportation Systems. This program was formally approved by the MIT Faculty in the spring and will begin admitting students in fall 1998. Another major development was the launching of the Engineering Research Center on "Innovative Product Development" (CIPD) sponsored by the National Science Foundation. This center, directed by Professor Warren Seering of the Department of Mechanical Engineering, is focused on the process of innovation and design of commercial products. CIPD is sponsored collaboratively by the Sloan School and has considerable involvement with industry.

The School also continued to develop educational and development links with universities and governments abroad. The program with Thailand, administered through the Technology Development Program at MIT and sponsored through the Suksapattana Foundation in Thailand, entered its second year with the Department of Chemical Engineering collaborating on the offering of a program in Chemical Engineering Practice at King Monkut Institute of Technology in Bangkok. Several research projects also are being carried out and additional academic programs in biotechnology, construction and management are being considered as part of this collaboration. The Technology Development Program also is collaborating with Malaysia on the development of a new, private technical university.

Finally, the School of Engineering entered into an agreement with the government of Singapore to assess engineering research and education at the two universities in this country.

AWARDS

The Bose Award for Excellence in Teaching was presented to Professor Donald R. Sadoway of the Department of Materials Science and Engineering. Don is both an inspired and an inspiring teacher. The Jr. Bose Award was presented to Assistant Professor Steven B. Leeb of the Department of Electrical Engineering and Computer Science. The Bose Awards are funded with gifts from the Bose Foundation in recognition of outstanding contributions to undergraduate education.

The Ruth and Joel Spira Awards for Teaching Excellence were presented this year to Professor Frans Kaashoek of the Department of Electrical Engineering and Computer Science, Professor Mary Boyce of the Department of Mechanical Engineering, and Professor Richard Lester of the Department of Nuclear Engineering. The Spira awards were established with a gift from Mr. and Mrs. Joel Spira to honor outstanding teachers in the three departments listed above.

Henry Ford II Scholar Award - This award is presented to the senior in the School of Engineering who has attained the highest academic record at the end of the third year and who has exceptional potential for leadership in the profession of engineering and in society. The recipient this year was Mr. Gregory R. Richardson, '97 of the Department of Aeronautics and Astronautics.

Barry M. Goldwater Scholarship - This scholarship is awarded on the basis of merit to students who are sophomores or juniors and who have excellent academic records and have demonstrated an interest in and potential for careers in mathematics, the natural sciences and those engineering disciplines that contribute significantly to the technological advances of the United States. This year we had one winner from the School of Engineering Ms. Melody M. Kuroda, a junior in the Department of Materials Science and Engineering.

Reinhold Rudenberg Memorial Fund - This prize is awarded to students based on their senior theses in the area of energy conversion.

Three awards were made this year to Luis H. Palacios, a student in the Energy Laboratory, for his thesis titled "Implementation and Calibration of a Laser-Induced Fluorescence System in a Diesel Engine," Peter C.L. Jaffee, a student in the Laboratory for Electromagnetic and Electronic Systems, for his thesis titled "Automated Polymer Gel Spinning," and Dennis Son, SB '96 in the Department of Mechanical Engineering, for his thesis titled "An Application of Shape Memory Metal Alloys: Artificial Muscle Actuators."

ENGINEERING COUNCIL

On July 1, 1996 Professor Edward F. Crawley was named as head of the Department of Aeronautics and Astronautics. In January 1997 Professor Warren P. Seering, director of the Center for Innovation in Product Development was appointed to Engineering Council.

ENGINEERING INTERNSHIP PROGRAM

In 1996-97, EIP placed thirty two sophomores with member companies, up from 30 sophomores in 1996. The total number of interns placed were 55. One new company joined the EIP.

In 1997, we have focused on building partnerships with the EIP companies, and on strengthening the ties with the SoE departments for EIP graduate student placement. As a result of participation in the MIT Career Assistance Re-Design team, more departments, centers, and student placement offices are aware of EIP. Selected students in EIP are working in international locations during their company assignments. A more diverse student body is applying to and being accepted by EIP companies.

MINORITY INTRODUCTION TO ENGINEERING AND SCIENCE

On October 12, 1996, The New England Board of Higher Education recognized the MIT MITES Program for outstanding leadership in encouraging underrepresented minority students from all corners of New England to aspire to and persist in science, mathematics and engineering studies and careers.

During the summer of 1997, 58 underrepresented minority high school juniors completed the six week residential program, up from 45 students in 1996. Of the 45 students that attended MITES 1996, 32 applied to MIT, and all 32 were accepted. Seventeen of the accepted students will attend MIT.

MITES applications have increased from 211 in 1995 and 586 in 1996 to 691 in 1997. Four new corporate sponsors supported the MITES 1997 session. Twenty-four faculty, alumni, and corporate panelists spoke about their experiences with the students this summer.

The new Entreprep initiative was well received by the students and visiting entrepreneurs. This year was the first for the MITES initiative, and plans for its continuation are underway.

After the Dallas event, two additional receptions for MITES were held by alumni. A MITES reception was held in San Francisco by Ariel Poler '88 and Malcolm CasSelle '91 at I/Pro Corporation. Another MITES reception was held at Booz Allen & Hamilton by Reginald Van Lee '79 and Gerald Adolph '75. Each reception was attended by more than 40 guests, and Engineering Dean Robert Brown spoke on behalf of the MITES Program.

We will continue to develop plans to support the new entrepreneurship initiative, MITES, and other initiatives such as mini-MITES (a local after-school outreach program).

Robert A. Brown

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Academic year 1996-1997 was a watershed for the future of the department. In the wake of nine retirements/ departures in June of 1996, the department conducted a detailed, extensive and professional strategic planning exercise. The result 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 future 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.

In terms of normal events, it was a strong year for the department. Undergrad enrollment began to climb, the MEng program grew, and departmental participation in SDM, with a first class of 35, was significant.

Only one faculty member was added, Prof. Carlos Cesnik in Materials and Structures, Prof. Ed Greitzer to leave to visit the United Technologies Research Center, and Prof. Steve Hall became the Assistant Department Head.

UNDERGRADUATE PROGRAM

Undergraduate Enrollment over the Last Twelve Years

| | 85-86 | 86-87 | 87-88 | 88-89 | 89-90 | 90-91 | 91-92 | 92-93 | 93-94 | 94-95 | 95-96 | 96-97 |
|------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Soph. | 106 | 120 | 96 | 103 | 75 | 76 | 61 | 33 | 36 | 36 | 30 | 46 |
| Juniors | 92 | 103 | 118 | 94 | 87 | 61 | 62 | 60 | 31 | 37 | 31 | 23 |
| Seniors | 106 | 98 | 105 | 130 | 104 | 104 | 73 | 66 | 66 | 38 | 37 | 29 |
| Totals | 304 | 321 | 319 | 327 | 266 | 241 | 196 | 159 | 133 | 111 | 98 | 98 |
| % of women | 18% | 16% | 19% | 21% | 25% | 23% | 27% | 28% | 32% | 31% | 29% | 26% |
| % of Under. min. | 11% | 10% | N/A | 14% | 18% | 20% | 14% | 12% | 23% | 19% | 16% | 18% |

GRADUATE PROGRAM

A total of 238 applications were received for the Fall, 1997 term. Out of this, 134 were admitted and 67 accepted the offer of admission. Enrollment for Fall, 1996 included 129 S.M., 70 Ph.D., 1 EAA, 10 MEng degree candidates for a total of 209. Total minority students: 12 (5 Ph.D., 6 S.M., 1 MEng). Total women students: 27 (6 Ph.D., 19 S.M., 2 MEng.). In the Spring, 1997 term we received 28 applications. We admitted 12 and 6 enrolled. Three women applied, 1 was admitted, 1 enrolled. Four minority applications were received zero enrolled. Enrollment for Spring, 1997 included 117 S.M., 63 Ph.D., 10 MEng for a total of 190. Total women: 24 (5 Ph.D., 17 S.M., 2 MEng.). Total minority: 8 (4 Ph.D., 3 S.M., 1 MEng.).

| Degrees Awarded | S.M. | EAA | Ph.D. | Meng | Total |
|-------------------|------|-----|-------|------|-------|
| Summer (Sept. 96) | 11 | 0 | 3 | 0 | 14 |
| Fall (Feb. 97) | 20 | 0 | 11 | 0 | 31 |
| Spring (June 97) | 22 | 0 | 7 | 7 | 36 |
| Total | 53 | 0 | 21 | 7 | 81 |

| FUNDING | FALL, 1996 | SPRING, 1997 |
|--------------------------------|------------|--------------|
| MIT Fellows/Tuition Awards | 10.5 | 8.5 |
| Outside Fellowship | 20 | 17 |
| Staff Appointments | | |
| (Draper Fellow, RA) | 137 | 132.25 |
| Teaching Assistants & Fellows | 6 | 4 |
| Engineering Internship Program | 2.5 | 2 |
| Other Types of Support | | |
| (Employer, Foreign, Self) | 36 | 30 |
| TOTAL | 212 | 193.75 |

FACULTY NOTES

Dr. Richard H. Battin received the Dirk Brouwer Award for 1996 given by the American Astronautical Society for innovative, fundamental contributions to the science and technology of Space Flight, and for inspired teaching of the astrodynamics arts to two generations of students.

Prof. Edward Crawley received the ASME Smart Structures Award at the 38th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference in Kissimmee, FL, April 7-10, 1997.

Prof. Alan Epstein was appointed to the MacLaurin Chair in the Department of Aeronautics and Astronautics.

Prof. Edward Greitzer received the Air Force Exceptional Civilian Service Award.

Prof. Nesbitt Hagood received the following awards:

- June 1996, Best Paper in Aircraft Design: 52nd Annual Forum of the American Helicopter Society.
- Nov. 1996, Presidential Early Career Award for Scientists and Engineers (PECASE).
- June 1997, ASME Adaptive Structures Best Paper Award in Structural Dynamics and Control.

Prof. Jack Kerrebrock was presented with a Distinguished Alumnus Award by Caltech on May 17, 1997.

Prof. Paul Lagace received the Class of 1960 Fellowship.

Prof. Earl Murman was honored by his professional colleagues from around the world at a symposium "Thirty Years of Computational Fluid Dynamics and Transonic Flow" in Everett, WA on June 24-26, 1997.

Professor Amedeo Odoni was appointed to the T. Wilson Chair in the Department of Aeronautics and Astronautics. He also became Co-Director (along with Professor Adib Kanafani of the University of California, Berkeley) of the National Center of Excellence in Aviation Operations Research (NEXTOR) which was established by the FAA in October 1996 to conduct advanced research on Air Traffic Management and on airport operations. The new Center consists of 4 core universities (MIT, Berkeley, U. of Maryland and VPI), 11 affiliated universities and 21 industry partners.

Prof. Thomas Sheridan received the 1997 National Engineering Award of the American Association of Engineering Societies.

Prof. Mark Spearing won the department's teaching award. A paper he co-authored: "Micro-Gas Turbine Engine Materials and Structures" won 2nd prize in the oral presentation category at the 21st Annual Cocoa Beach Conference and Exposition of the American Ceramic Society, at Cocoa Beach in Florida (January 12-16, 1997). My co-author was Kuo-Shen Chen, a graduate student in Mechanical Engineering. Since there were nearly 300 papers at the conference, it represents a significant achievement.

Prof. Larry Young was selected as First Director, National Space Biomedical Research Institute. He was also elected to International Academy of Astronautics.

MASSACHUSETTS SPACE GRANT CONSORTIUM

The Massachusetts Space Grant Consortium whose director is Laurence R. Young now includes MIT (Lead), Tufts University, Wellesley College, Harvard University, Boston University, University of Massachusetts, Worcester Polytechnic Institute and the Charles Stark Draper Laboratory. The Wright Center at Tufts is responsible for education of pre-college teachers in space science and engineering, through summer workshops. The Program continues to support undergraduate research through the MIT Undergraduate Research Opportunities Program. It increased the number of companies involved in placing students for summer employment in the aerospace industry, supported students for the summer at the NASA Space Academy, and offered graduate fellowships. It sponsored a popular undergraduate seminar subject on "Modern Space Science and Engineering" with emphasis this year on humans in space with guest speakers from our industrial affiliates, academic affiliates and astronauts. The annual public lecture this year was given by Dr. Christopher P. McKay, Scientist, NASA Ames Research Center.

The third meeting of the Massachusetts Space Forum was held in December 1996. The goal of the Massachusetts Space Forum is to favorably influence national planning and to stimulate regional cooperative activity in space education and business opportunities. Over 50 leaders from academia, industry and government attended the workshops and the luncheon presentation by Mr. David W. Thompson, President, Orbital Sciences Corporation.

The next Space Forum is tentatively scheduled for early Fall 1997.

RESEARCH HIGHLIGHTS

ACTIVE MATERIALS & STRUCTURES LABORATORY

The Active Materials and Structures Laboratory (AMSL) focuses on the development of innovative technologies for active control of aerospace systems. Research has covered a broad range of disciplines including materials science, structural mechanics, structural dynamics, control, and solid state actuation systems. The laboratory has coordinated multidisciplinary research programs ranging from fundamental materials microstructure investigations to helicopter control systems feasibility studies. Major research thrusts in 1997 were: development of new compositions and synthesis techniques for active ceramic materials suitable for actuation and sensing functions; development and characterization of active fiber composite material systems suitable for structural shape and vibration control, as well as the institution of a new DARPA funded consortium, the Active Fiber Consortium, established to help commercialize the technology; development of solid state actuation devices; and the establishment of new control algorithms and microelectronics hardware for distributed control architectures. Fundamental research was motivated by a variety of ongoing applications programs. AMSL, a member of the SmartStructures Rotorcraft Consortium with Boeing and McDonnell Douglas, has continued to work on developing actively controlled helicopter rotor blades for vibration and noise reduction. In a cooperative program with the Jet Propulsion Laboratory, AMSL developed ultrasonic motors suitable for space robotics applications. The laboratory also continued to advance applications projects in the active control of structural acoustics: both far field radiated sound from panels and cylinders as well as control of interior noise in aircraft. The laboratory facilities available were in active material and device characterization, static and dynamic structural testing, and real time control.

INTERNATIONAL CENTER FOR AIR TRANSPORTATION

The International Center for Air Transportation was formed this year by merging the Aeronautical Systems Laboratory (ASL) and the Flight Transportation Laboratory (FTL) which continue to operate as sub elements of ICAT. The objective of ICAT is to improve the safety, efficiency and capacity of domestic and international air transportation and its infrastructure, utilizing information technology and systems analysis. ICAT builds on the existing strengths of FTL in operations research and airline management, and ASL in flight operations and "human in the loop systems". The principle new thrust of ICAT over the past year has been in advanced Air Traffic Management. The activities have ranged from evaluations of future operational concepts; development of alerting systems such as conflict alerts; evaluation of analytical models of ATM systems and conducting fundamental human performance studies. The ASL element of ICAT continued to work in the areas of cognitive systems and decision aids for flight critical systems. This work includes advanced alerting systems, human understanding of advanced flight automation systems and other flight safety topics. The FTL element of ICAT continued its work in support of airline and airport operations.

Over the past year, ICAT was recognized as part of 2 separate "Centers of Excellence" by the Federal Aviation Administration (FAA). The Joint University Program in Air Transportation where MIT has participated with Princeton and Ohio University was selected to receive the first FAA Excellence in Aviation Award. In conjunction with the MIT Operations Research Center and the University of California at Berkeley, the center was selected as the principle elements of FAA National Center of Excellence in Operations Research.

FLUID DYNAMICS RESEARCH LABORATORY

The 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; the development of tools for aerodynamic design; distributed visualization; computational and experimental approaches to active flow control; large-scale numerical simulations of unsteady transitional and turbulent shear flows; an experimental investigation into roughness-induced boundary layer transition; the development of micron-sized shear-stress, pressure and velocity sensors for measurement and control of high Reynolds number, sub- and supersonic aerodynamic flows; analysis and simulation of the mechanics of fluids in micron-sized geometries, including fluid mechanics of a micro-gas-turbine engine; the development of theoretical models for the dynamics of near-wall turbulent flows.

GAS TURBINE LABORATORY

LEAN AIRCRAFT INITIATIVE

The LAI project began a three year Phase II on September 1, 1996 with Prof. Wesley Harris serving as Director during Prof. Earll Murman's sabbatical. The LAI goals are to define the major change agents in acquisition, development, manufacture and related government and supplier regimes which can dramatically improve cost, schedule and quality in the U.S. aircraft industry. During Phase I, research findings were captured in a Lean Aircraft Model (LEM) and delivered to the project sponsors which include all major government and industrial organizations involved in producing and procuring military aircraft systems. Phase II research involves faculty, staff and students from the School of Engineering, Sloan School, and Center for Technology, Policy and Industrial Development. Further information can be found at <http://web.mit.edu/lean/>.

MAN VEHICLE LABORATORY

MVL continued its active involvement in human space flight research. The Advanced Dynamic Load Sensors experiment was conducted aboard the MIR Station. Development continued of a virtual reality based experiment on human visual orientation in weightlessness for the Neurolab Shuttle mission in the Spring of 1998. A follow on experiment was approved for flight on the International Space Station, working in collaboration with French, Italian, and Canadian colleagues. In March, NASA announced the formation of a National Space Biomedical Institute (NSBRI) by a consortium of 7 universities, including MIT. Professor Laurence Young will be the first Director. Dr. Charles Oman leads the Institute's Neurovestibular research program. Several related NSBRI research projects are expected to begin in the fall of 1997. Related academic activities by MVL faculty include a seminar on the case for human exploration of the solar system. Meanwhile, MVL ground based research on human spatial orientation in real and virtual environments, tactile cueing systems continues, EVA biomechanics, artificial gravity physiology and human factors. FAA sponsored flight simulator research on cockpit displays for GPS instrument approaches also continues, in collaboration with the DOT Volpe Center in Cambridge.

SPACE ENGINEERING RESEARCH CENTER

Autonomous Mission Scheduling for Satellite Operations

When satellite mission operations are examined with an eye towards reducing costs, scheduling and planning is a prime area for consideration. Scheduling daily instrument activity tends to be tedious and repetitive. In addition, the problem is not trivial. Larger missions can have many instruments with thousands of constraints, making it difficult to generate a feasible schedule, much less an optimal one.

Since the cost of an automated scheduler is in the development, not the operation, a generic scheduler that can easily be adapted to many different satellite missions would be very useful. Satellite missions vary widely, so "classes" of missions that share some basic characteristics are defined. Schedulers are developed and demonstrated for several of these classes.

Analysis Tools and Architecture Issues for Distributed Satellite Systems

The recent development of several new technologies has made the concept of a distributed satellite system feasible. The term "distributed satellite system" is used to refer to a system of many satellites designed to operate in a coordinated way in order to perform some specific function. This definition encompasses a wide range of possible applications in commercial, civilian and military sectors. The advantages offered by such systems can mean improvements in performance, cost and survivability compared to the traditional single-satellite deployments. This makes their implementation attractive and inevitable. The emphasis of this work is to highlight the important concepts and issues associated with distributed satellite systems through the development of metrics for quantifying the cost, capability and adaptability of distributed satellite systems compared to single-satellite deployments. This analysis methodology also assists in the identification of the key technology drivers associated with the development of such systems.

There are many different ways to design satellite systems to perform essentially the same task. In order to compare alternate designs, a metric is required which fairly judges the performance of the different systems in carrying out the required task. In today's economic climate, there is also a requirement to consider the monetary cost associated with different levels of performance. Due to the extremely large capital investment required for any space venture, it is especially true for satellite designers that the objective is to provide the customer with the best value. The case in point here is that for a distributed system to make sense compared to another way of achieving the function, it must offer reduced cost for similar levels of performance. This hints to the possible benefits of a definable of a *cost per performance* metric. Performance and cost metrics can be used as design tools by addressing the sensitivity in performance and cost to changes in the system components, or by identifying the key technology drivers. This leads to the definition of the *adaptability* metric that quantifiably measures the sensitivity to changes in the design or role. The last metric used for generalized analysis is the *capability* metric that assesses the potential capabilities of the system.

Linear Ion Microthruster

Future spacecraft may employ microthrusters for missions requiring precise, low thrust firings. These missions may include precision station-keeping of separated spacecraft forming a large sparse aperture, control of large flexible structures such as deployable antennas or solar arrays, or as the main propulsion system for microsatellites. The goal of this work is to evaluate whether a JPL-proposed linear ion microthruster can address these needs. An analytical model is being developed to predict thrust, specific impulse, ion energy cost per beam ion, and efficiency for the linear chamber scale and geometry. The analytic code is based on models currently used to predict performance in traditional ring cusped engines.

SPACE POWER AND PROPULSION LABORATORY

The Space Power and Propulsion Laboratory (SPPL) is a part of Space Systems Laboratory (SSL) which focusses on interactive problems related to the propulsive and power generating systems of spacecraft. The Propulsion activity has continued to focus on various aspects of Electric Propulsion and space mission planning. A very small (50W) Hall thruster which was designed and built last year, has satisfactorily undergone preliminary tests; although a new trust balance will only become available this Fall, voltage-current-flow characteristics obtained with Argon gas show operation in the intended regime and with apparently good efficiency. Theoretical work has continued on alkali-seeded hydrogen arcjets, which offer high efficiency potential at moderate specific impulses; An electrothermal-ionization stability analysis has been completed, showing that snap-over to classical arc operation with large hydrogen frozen losses is not expected throughout the intended regime of seeded arc operation. Two-dimensional model development continues. Hall thruster PIC models have been extended and refined, and are being applied to guide design efforts at BUSEK, Inc. A program of experimental probing of internal plasma properties in Hall thrusters is being pursued in cooperation with the Air Force Phillips Laboratory at Edwards AFB, CA. The Gamma Ray Burst mission being prepared in cooperation with the Center for Space Research has evolved to an all-chemical propulsion architecture, involving an Ariane 5 ASAP launch; this will yield lower mission costs than the earlier Electric Propulsion version, and was made possible through trajectory studies performed by one of SPPL's graduate students (Chris McLain). The Laboratory is participating in the design of a bare tether demonstration mission that will fly in 1999 as a secondary Delta payload. The mission, sponsored by NASA Marshall SFC, grew out of theoretical studies by Prof. Martinez-Sanchez and visiting professors J. Sanmartin and E. Ahedo, which showed that a very efficient electron-capturing contactor for an electrodynamic tether mission can be

implemented by leaving a section of the tether exposed to the ambient plasma. Finally, a systems study is being completed of a future gaseous core nuclear rocket in which the strong vortex flow required for containment is provided by MHD forces using electricity generated on-board from the reactor's waste heat.

SPACE SYSTEMS LABORATORY

Submicron Dynamics and Thermal Snap Response of Deployable Truss Structures

The hunt for Earth-like planets orbiting other is one of the primary objectives of NASA's Origins Program, which will launch a number of space-based observatories, starting early in the next decade. Due to the size constraints imposed by the payload bay of carrier spacecraft, these telescopes will undoubtedly require some form of on-orbit deployment mechanism, including joints or hinges which will introduce non linearity to the structure. The success of the Origins missions will hinge on whether positioning of the optical elements can be maintained to within fractions of the viewing wavelength. Consequently, any minute disturbance will pose a serious threat to the stability of the precision optical systems. Acquiring a better understanding of the effects of damping and structural nonlinearities on the submicron-level dynamics is therefore essential to the telescope design.

The overall objective of the ongoing research is to perform an experimental and analytical investigation of the microdynamics of deployable truss structures. Specifically, the main goal is to characterize the dynamic response of such nonlinear structures at sub-microstrain levels of mechanical and thermal excitation. In the case of mechanical excitation, the response will be characterized in terms of modal parameters (the natural frequency and damping ratio). The response to thermal excitation will be characterized in the time and frequency domains.

Distributed Satellite Systems

The goal of the program in Distributed Satellite Systems (DSS) is to identify the functions within spacecraft and between spacecraft that can benefit from distribution. Over the past several decades, the computer industry has evolved from using large, expensive mainframes for solving computationally intensive problems to using smaller, cheaper, more adaptable distributed sets of workstations collaborating to solve equivalent sized problems. Likewise, DSS will demonstrate how distributed arrays of smaller, cheaper spacecraft can achieve the same missions as current larger, more expensive, monolithic spacecraft with improved performance at lower cost.

To achieve this goal, the DSS program employs systems analysis concurrently with experimental work. Presently, U.S. Air Force space missions are being classified according to how much they might benefit from distribution, and metrics for evaluating DSS designs are being developed. All experimental work is done with the DSS Testbed. Phase I of the Testbed, which demonstrated the capability to perform acoustic interferometry, has been completed. Phase II of the Testbed, which will demonstrate achieving function with a distributed system of "satellites," is currently being designed with construction to begin later in the summer. Future milestones include developing software for controlling distributed satellite systems, designs of actual DSS missions, and a possible space flight experiment.

NASA: Advanced Spacecraft Architectural Concepts

The goal of the ACRP is to develop Advanced Spacecraft Architectural Concepts (ASAC) using Modular & Multifunctional units (MMSC). Functions conventionally provided by various specifically designed single function components are integrated into standardized modules. Given spacecraft functionality requirements and technical specifications, the spacecraft can then be built by assembling these basic modules together. Interfaces among these modules can also be standardized to allow easy assembly as well as flexibility for the spacecraft design.

To achieve this goal, the ASAC project moves forward in three phases. Phase I, which has already been completed, included a review of current NASA spacecraft architectures, identification of spacecraft missions and subsystems that could benefit from the MMSC concept, and requirements definition. Phase II, currently underway, consists of designing the MMSC modules and developing the interfaces and protocols between modules. Phase III will culminate with a full end-to-end design of a NASA science mission using MMSC concepts developed in Phases I and II.

Active Acoustic Load Launch Alleviation

The MIT Space Systems Lab (SSL) is teamed with Air Force Phillips Lab and McDonnell Douglas Aerospace on the Active Acoustic Launch Load Alleviation (AALLA) project. The goal of the project is to reduce the acoustic

loads on spacecraft during launch by controlling the transmission and reflection of sound through the payload fairing. If successful, this research could significantly reduce the loads that account for more than 40% of first-day spacecraft failures.

An impedance matching control method is being developed for this project. This method is unique in that it only requires knowledge of the fairing structure and local acoustic coupling. In addition, sensors are only required on the fairing, not on the payload where they may interfere with deployment or performance. Currently, research at MIT is focused on proving the impedance matching concept through experiments in an acoustic test chamber.

Alternate Hall Thruster Geometries

The primary advantage of electric propulsion is a reduction in propulsion system wet mass, which can be used to improve payload effectiveness, extend satellite lifetime, and/or reduce launch costs. Hall thrusters are at the forefront of current electric propulsion research and development programs. The goal of our research is to numerically model Hall thrusters and their interactions with the host satellite. We are currently refining and extending two dimensional code developed to model the Russian SPT-100 thruster such that it accurately predicts the behavior of alternate Hall thruster geometries.

Dynamic Modeling of Hall Thrusters

Early efforts to develop Hall thrusters in the United States were abandoned, partly due to plasma instabilities which prohibited steady reliable operation. Russian designs eventually proved reliable, but oscillations were still present in the discharge. We are undertaking a program of Hall thrusters modeling which will help understand the physical nature of Hall thruster discharge oscillations and their effect on operational characteristics. In addition, our model is helping to understand other phenomenon such as "anomalous" electron conductivity in the Hall thruster plasma.

Precision Space Telescope Testbed

The MIT Space Systems Laboratory has designed and constructed a testbed whose structural dynamic response is similar to that of proposed next generation space telescopes: the Space Interferometry Mission (SIM) and the Next Generation Space Telescope (NGST). The research goal is to address challenges faced by NASA's Origins Program telescopes in areas related to dynamics and control, and to ensure that the results are applicable to these missions.

The testbed is designed to be as satellite-like as possible, and is neutrally stable at its axis of rotation to enable a one-axis slew maneuver. A reaction wheel assembly mounted at the bottom of the spacecraft bus section is used to slew the testbed. Disturbances traceable to those anticipated for the next generation space telescopes are engendered by the reaction wheels. The testbed's performance is measured with an optical system, which simulated the optical train of the space telescopes.

TECHNOLOGY LABORATORY FOR ADVANCED COMPOSITES

Over 30 students were involved with TELAC during AY 96/97 including 16 graduate students, a similar number of UROPers, and a number of students in 16.621/2 who performed their projects in TELAC. Five students finished their master's theses in the laboratory during this period and one doctorate was completed. In addition, the laboratory was host to a visiting faculty member, Earl Thornton of the University of Virginia, in the fall and to a visiting student from the International Space University in the spring. This student completed a project during this period under the guidance of Hugh McManus. The laboratory issued a total of 18 reports during this period including a number accepted for publication in journals and proceedings. Laboratory personnel participated in conferences at the national and international level giving a total of 7 presentations. Included in these was a paper given by Paul Lagace at the biennial DoD/NASA/FAA Conference on Fibrous Composites in Structural Design held in Ft. Worth in August. The new approach to the design of composite structures which has been developed by the laboratory faculty over the past several years was further described and was well-received by an audience mainly of industry practitioners. This approach continues to be presented and discussed around the country and the world and is continuing to receive widespread acceptance and support. The faculty hope to build on this to soon begin a new sponsored program in this area. Major progress was made in a coordinated effort aimed at understanding the effects of severe environments on the durability of composite structures. Thermal, chemical and mechanical effects on the material are all considered, using a material modeling approach. The understanding is being used to develop design methodologies to insure performance over long lifetimes in such challenging environments, and to design scaled or accelerated test methods for such applications as the HSCT and X-33 vehicles, engine components, and satellite structures. The same design methods are being used in-house to build and test a microsatellite structure for Draper

Laboratories. Other major research accomplishments during the year include the identification of fundamental failure mechanisms in hybrid composite laminates; application of an approach, using design diagrams, for the design of metal-composite joints; continued extension of the understanding of impact behavior in composite structures, particularly in regard to shell configurations; an ability to predict the geometric nonlinear behavior of pressurized composite cylinders, simulating fuselage structures, and a furthering of the understanding of the effect such behavior has on these structures; and the development of an ability to numerically model the snap-through behavior of transversely-loaded composite shells using the STAGS code. A significant event this year was the hosting of the "Second Student Symposium on Composite Materials" between the students working on composites at Virginia Tech and those in TELAC at M.I.T. The first very successful such exchange occurred at Virginia Tech in 1996 and TELAC hosted this event for the first time during March, 1997. A final note is that the laboratory technician of nearly twenty years, Albert Supple, retired. A gathering of laboratory members and alumni/ae in September congratulated him on his accomplishments. The laboratory also welcomed a new technician, John Kane, in September.

WRIGHT BROTHERS WIND TUNNEL

The primary test activities fell into two classes. The first is the use of the wind tunnel for educational purposes. In the past year there were no 16.621-16.622 projects:

The second were commercial use of the wind tunnel to determine wind loads and pedestrian level winds for proposed construction in Boston.

- Pedestrian level wind for a hotel at World Trade Center.
- Pedestrian level wind for City Hall Plaza.
- Pedestrian level wind for proposed Colonnade Residence.
- Pedestrian level wind at north end of East Office Building at the World Trade Center.

The Wright Brothers Wind Tunnel is part of a round robin anemometer testing program conducted under the sponsorship of the Institute for Meteorological Standards. We were pleased by the outcome of the tests conducted at the Wright Brothers Tunnel. In spite of its age, the tunnel exceeds world standards for calibrating this class of anemometer.

The other use was for calibration of Second Wind Anemometer.

The commercial testing used 41.85 wind on hours this year.

DEPARTMENT AWARDS

UNDERGRADUATE

The David J. Shapiro Memorial Award is given to Aero & Astro undergraduate students to "pursue special aeronautical projects that are student-initiated, and/or to support foreign travel for the enhancement of scientific/technical studies and research opportunities." This year's recipients of the Shapiro award are--

| | | |
|--------------------|-----------|--------------|
| Sabrina D. Almeida | Sophomore | Bethesda, MD |
|--------------------|-----------|--------------|

"For support and enhancement of scientific/technical studies" at the École Nationale Supérieure de L' Aéronautique et de L' Espace (Sup' Aero), Toulouse, France, during AY 97-98.

| | | |
|------------------|-----------|--------------|
| Phillip E. Reich | Sophomore | El Cajon, CA |
|------------------|-----------|--------------|

"For support and enhancement of scientific/technical studies" at the Imperial College, London, England, during AY 97-98.

The Apollo Program Prize given to an Aero & Astro student who "conducts the best research project on the topic of humans in space" is presented to--

Esther S. Dutton

Senior/Grad

Merritt Island, FL

"In recognition of her contributions to human space flight through exemplary educational curriculum development efforts and analysis of the spacecraft development process."

The Yngve K. Raustein Award was established in memory of Yngve K. Raustein, a member of the MIT class of 1994, whose untimely and tragic death in September 1992 saddened the entire MIT and Cambridge community. In the fall of 1991, Yngve transferred from the University of Bergen in his native Norway to major in our department. His interest in space technology, initially kindled by the Challenger accident in 1986, continued to grow while he was at MIT. Yngve was active in the Students for the Exploration and Development of Space program, and traveled to the Kennedy Space Center to watch the Space Shuttle Discover launch in January 1992. He lived in Baker House, where he made many friends.

The Raustein award is given to a Unified Engineering student who "best exemplifies the spirit of Yngve Raustein and to recognize significant achievement in Unified Engineering". This year the Raustein award is presented to:

Keith Amonlirdviman

Sophomore

Chicago, IL

"By his willingness to take on the challenge of pursuing Unified Engineering during his freshman year, and by his outstanding performance, Keith exemplifies the spirit that Yngve brought to Unified".

The Unified Engineering Award was established to recognize the hard work of the Unified head graduate teaching assistant. This year we recognize--

Raymond J. Sedwick

Ph.D. Candidate

Chicora, PA

"For outstanding devotion to and leadership of the team of student assistants in Unified Engineering, as well as skillful organization and planning to achieve smooth operation of the complex Unified Engineering enterprise."

The Andrew G. Morsa Award is given to undergraduate students "for demonstration of ingenuity and initiative in the application of computers to the field of aeronautics and astronautics." This year's Morsa award goes to--

Jaime Amaya

Junior

San Juan, TX

"For demonstrated ingenuity, initiative, creativity, and skill in developing a World Wide Web version of the Lean Aircraft Initiative Program Lean Enterprise Model to aid aerospace companies to implement practices to improve quality and reduce costs."

The Leaders for Manufacturing Award was established in 1991 by our own Prof. Eugene Covert and is given to 16.62x students "for some activity related to skills in one of several activities associated with manufacturing". This year's recipients of the LFM prize are--

Marcus Ottaviano

Senior

King of Prussia, PA

Jimmy Yeh

Senior

San Leandro, CA

"For their mature and entirely independent analysis of manufacturing variance in graphite-epoxy specimens; for their design and implementation of quality-control checks and the determination that the specimens could be used without compromising the validity of the data; and for the design of test matrices to minimize the effects of manufacturing variations on the test results.

The Admiral Luis De Florez Prize was established to encourage undergraduates to be imaginative and creative. This year's recipients are--

Christian L. Anderson

Senior

Cody, WY

Rodgerick L. Newhouse

Senior

Mt. Morris, MI

“For pursuing an original project to analyze energy loss mechanisms of in-line skates, and for ingenuity in developing appropriate instrumentation and in performing measurements.”

The James Means Memorial Award was established by Dr. Means, a former physician at MIT for many years, in honor of his father who was an aeronautical enthusiast. The award recognizes excellence in both flight vehicle engineering--16.82, and in space systems engineering--16.83. This year's winners are--

| | | |
|-----------------------|--------|--------------|
| Staci N. Jenkins | Senior | Pasadena, MD |
| Heather Noyes | Senior | FraminghamA |
| Gregory G. Richardson | Senior | Nat, MA |

“For significant leadership in helping the undergraduate space systems engineering class to converge on a design for a mission to search for evidence of life on Mars.”

| | | |
|-----------------------|--------|----------------|
| Rodgerick L. Newhouse | Senior | Mt. Morris, MI |
|-----------------------|--------|----------------|

“For excellence in the architecture and design of the payload and guidance avionics systems for a ship-borne unmanned surveillance vehicle.”

The Henry Webb Salisbury Award was established in memory of Henry Webb Salisbury to recognize academic achievement by a graduating senior or seniors. This year's recipient of the Salisbury award is--

| | | |
|-----------------------|--------|------------|
| Gregory G. Richardson | Senior | Natick, MA |
|-----------------------|--------|------------|

“For achieving academic excellence in the Department of Aeronautics and Astronautics.”

GRADUATE

Fall 1996

| | |
|------------------|--------------------------------------|
| Jonathan Elliott | Edward Taylor Teaching Fellow |
| Raymond Sedwick | Raymond Bisplinghoff Teaching Fellow |
| John Schewchun | Charles Stark Draper Teaching Fellow |

Spring 1997

| | |
|-----------------|--------------------------------------|
| Angie Kelic | Judy Resnik Teaching Fellow |
| Raymond Sedwick | Raymond Bisplinghoff Teaching Fellow |

FUTURE PLANS

In the past year, the Department established its future strategic direction. The next year will be marked by the detailed planning to implement that strategic direction. Six working groups will set out to shape the future: System Architecture and Engineering; Aerospace Information Engineering; the Engineering Context of our Education; Academic Program Planning; Research Planning; and International Programs.

In parallel we will work to establish major strategic relations with industry, and search intensively and comprehensively to rebuild the faculty which will implement our collective future vision.

Edward F. Crawley

DEPARTMENT OF CHEMICAL ENGINEERING

1996-97 was Professor Robert C. Armstrong's first full year as Department Head in Chemical Engineering. Our research volume increased, student enrollment was strong and faculty awards and promotions were all indicators of continued strength in the Department. Completion of renovations in Building 56 allowed our faculty and students in the biochemical and biomedical engineering to begin to consolidate their activities in the same physical area. This year we also had a meeting with our Visiting Committee.

On the administrative side, we created, with the Department of Materials Science and Engineering, an Administrative Services Unit (ASU) that consolidates the non-student related administrative function of the Departments. Ms. Elizabeth Cooper was appointed the Director of Administrative Services. Ms. Michelle Shippie has joined the ASU as Personnel Officer and Ms. Gerti Gillen as the Fiscal Officer. The ASU is now fully staffed and located between the two departments in temporary quarters in building 26.

The Department continues to maintain high student enrollments. For the 1996-97 academic year our undergraduate enrollment included: 87 sophomores, 121 juniors and 110 seniors. The high undergraduate enrollment will continue as 96 Sophomores have pre-registered for the coming year, thus placing continued pressure on our undergraduate teaching facilities and our faculty. The Undergraduate Polymer Laboratory, completed in 1996 in building 31 continues to be oversubscribed, indicating the importance of this laboratory course offering to the Department.

Applications to our graduate program indicated a high level of interest from excellent students. From the 412 applications received, we offered 14% of the applicants admission and 69% of the students have accepted this offer; this yield is higher than the 64% of the previous year. There were 35 students in the David H. Koch School of Chemical Engineering Practice; these students participated in projects at our Dow Chemical Company station Midland, Michigan and Freeport, Texas and at Merck in West Point, Pennsylvania. This year we added a new station at Mitsubishi Chemical Co. in Mizushima, Japan. Support of our graduate research continues at a high level with approximately \$20M of research funding; 25% of these funds come from Industry.

We conducted an extensive search for a new faculty member and recruited Dr. William Green as an assistant professor. Dr. Green is a graduate of the University of California, Berkeley and has been at Exxon Research and Engineering for the past 6 years. He will join us August 1, 1997. Professor Daniel Blankschtein was promoted to full professor. It was very gratifying to name Professor William Deen as the Carbon P. Dubbs Professor of Chemical Engineering and Professor Klavs Jensen as the Lammont DuPont Professor of Chemical Engineering. In addition, funding for the Herman P. Meissner Chair in Chemical Engineering was completed this past year; Professor Jefferson Tester was named as the first Meissner Professor.

Several of our faculty received awards of special note during the past year. Professor Robert A. Brown received the Professional Progress Award from the American Institute of Chemical Engineers, Professor Robert Langer was the recipient of the Killian Faculty Achievement Award, the Gairdner Foundation International Award and the AIChE William Walker Award. Professor Paula Hammond receive a NSF 1997 CAREER Award, as well as the EPA Early Career Research Award and the DuPont Young Faculty Award for 1996. Professor Paul Laibinis received a Young Investigator Award from the Office of Naval Research. Professor Jackie Ying was named recipient of the ACS Award in Solid State Chemistry.

UNDERGRADUATE EDUCATION

For the year 1991-92, sophomore enrollment was 96, juniors 72, seniors 58, total 226; 1992-93 sophomores 95, juniors 89, seniors 81, total 265; 1993-94 sophomores 115, juniors 90, seniors 84, total 289; 1994-95 sophomores 108, juniors 104, seniors 100, total 312; 1995-96 sophomores 118, juniors 101, seniors 103, total 322; 1996-97 sophomores 87, juniors 121, seniors 110, total 318.

Enrollment, which has increased steadily since the 1987-88 academic year, seems to have leveled off. We continue to project a sophomore class next fall of about 100. The classes continue to include about half women, and interest in biomedical and biochemical applications of chemical engineering remains strong.

Our new polymer laboratory has doubled our capacity in that popular subject, but resources for the other undergraduate laboratories continue to be strained. Teaching and advising loads are heavy, with the department having the highest student-to-faculty ratio at the Institute.

A survey of the Class of 1997 shows that about 39 percent of this class is going on to graduate school, 15 percent to medical school and 46 percent into industry.

GRADUATE EDUCATION

In the 1990-91 year, Masters enrollment was 59, Doctoral enrollment was 164, total 223; 1991-92, Masters 37, Doctoral 164, total 201; 1992-93 Masters 51, Doctoral 159, total 210; 1993-94, Masters 62, Doctoral 147, total 209; 1994-95, Masters 64, Doctoral 166, total 230; 1995-96, Masters 56, Doctoral 169, total 225. 1996-1997 new numbers Masters 64; Doctoral 162; Total 226.

The total for 1996-97 includes 69 foreign students, 57 female students, and 13 minority students (not including Asian Americans). Graduate admissions data suggests that graduate enrollment will remain in the low 200s for the next several years.

A total of 35 students participated in the David H. Koch School Of Chemical Engineering Practice School Program during the 1996-97 calendar year. The Dow Station was relocated from Midland, MI, to Freeport, TX, in January 1997, while year-round operations continued at the Merck Manufacturing Division in West Point, PA. Summer stations were established at Dow Corning in Midland, MI, and at the Mizushima facilities of the Mitsubishi Chemical Corporation in Japan. This latter station highlights the recognition of the importance of globalization in today's economy, and provides selected students with an exposure to alternative corporate cultures. This is the first time a Practice School Station has been established outside of the United States. These stations provided a wide variety of excellent projects and opportunities for the students. Dr. Janet Griffiths and Dr. Barry Johnston continued to serve as directors of the West Point and Midland Stations, respectively, during the Fall, 1996, semester. Dr. John Friedly assumed the Merck Station Director duties in January, 1997, while the Freeport Station was inaugurated under the direction of Dr. Chris Quinn. The Midland Summer Station was directed by Dr. Paul Huibers, a Post-Doctoral Associate at MIT, and the Mizushima station by Dr. Andrea O'Connor, a lecturer from Melbourne University, Australia, with assistance from Dr. Angelo Kandas, a recent graduate of the Chemical Engineering Department. Professor T. Alan Hatton continues to direct the Practice School from Cambridge. A Chemical Engineering Practice School program has been established in Thailand for the training of Thai engineers for the local industries; MIT faculty have served in an advisory capacity to assist in the development of this program, which is independent of MIT.

FACULTY NOTES

Professor Robert Armstrong gave a keynote lecture at the XIIth International Congress on Rheology in Quebec in August. Later in the year he gave a keynote lecture at the 50th Annual Conference of the Society of Imaging Science and Technology. He also gave a seminar to the Department of Chemical Engineering at Clemson University and the Department of Macromolecular Science of Case Western.

Professor Paul I. Barton received an award from the Exxon Education Foundation and a Dupont Educational Aid grant. Professor Barton was listed in *Who's Who in Information Technology*. In June 1997, he founded the ABACUSS Project, a Industry/University Research Consortium to design and implement the next generation of process modeling software.

Professor Janos M. Beer has been reappointed to the National Coal Council, the Advisory Council of the Secretary of Energy. He has been awarded the degree of Doctor Honoris Causa by the Technical University of Budapest, Hungary.

Professor Daniel Blankschtein was promoted to full professor effective July 1, 1997. He was an invited speaker and Discussion Leader at the Science Planning and Research Knowledge (SPARK) Workshop on "Physical Detergency", held in Llandudno, North Wales in November 1996, and a Plenary Speaker at The Society of Cosmetic Chemists Annual Scientific Meeting, held in Nashville in May 1997. He was appointed to the Editorial Board of

"The Surfactant Science Series", edited by Marcel Dekker, in July 1996. In the 1997 Spring semester Professor Blankschtein co-taught a new course entitled "Colloid and Surfactant Science" with Professors Hatton and Laibinis.

Professor Howard Brenner, W.H. Dow Professor of Chemical Engineering, was an Invited Keynote Lecturer at the Second Joint China/US Chemical Engineering Conference held in Beijing in May, 1997. He was appointed to the National Academy of Engineering Awards Committee which administers the major awards of the Academy, and will serve as Chairman of that Committee next year. Together with several co-investigators, he was awarded a highly competitive three-year "Grand Challenge" research award by the Department of Energy. A three-volume Festschrift collection of papers by friends, former students, and admirers was published by the research journal "Chemical Engineering Communications" to honor him on his 65th birthday.

Professor Robert A. Brown continued to serve as Dean of Engineering at MIT. He received the Professional Progress Award of the AIChE, and was the Julien Smith Lecturer in the Chemical Engineering Department at Cornell and the Lindsey Lecturer at Texas A&M University. He served as chair of the National Academy of Engineering's conference, "Frontiers of Engineering," held in September 1996 and is serving as co-chair of the first US/German meeting on the "Frontiers of Engineering," which is being organized for spring 1998. Professor Brown also gave the Peter Danckwerts Lecture for the Institution of Chemical Engineers in Great Britain.

Professor Charles L. Cooney continues to serve as the Executive Officer of the Department. He was chair of the Corporate Relations Faculty Committee and a member of the Council on Industrial Relations. During the year he co-founded the Consortium for Advanced Manufacturing of Pharmaceuticals (CAMP) an industry consortium jointly run with Purdue University. He also gave a presentation "Biotechnology in the 21st Century" on the occasion of the 20th anniversary celebration of the MIT-Japan Industrial Liaison Office.

Professor William M. Deen succeeded Professor Edward W. Merrill as the Carbon P. Dubbs Professor of Chemical Engineering. Professor Deen was an invited speaker at the NIH Conference on Assessment of Renal Structure and Function in Progressive Renal Disease, which was organized to identify future research needs. He also received the 1997 Outstanding Faculty Award from the graduate students of the Department.

Professor Linda G. Griffith gave the plenary lecture last winter at the Annual Meeting of the Orthopedic Research Society in San Francisco, on the topic of "Tissue Engineering: Lesson Learned from Liver". Following a publication in the journal Nature Medicine, her work in the area of growing livers in vitro was featured last fall in The New York Times Science Times and in Newsweek's "Inaugural Issue" in a feature story about tissue engineering. Currently, she is working with 2 MIT graduates to start a company for in vitro drug metabolism and toxicology testing, based on her novel approach for creating in vitro vascularized tissue.

Professor Paula T. Hammond received the 1997 National Science Foundation CAREER Award, a grant that has replaced the former NSF Young Investigator Award Program. Professor Hammond also received the Environmental Protection Agency (EPA) Early Career Research Award, which includes five years of research funding, and the DuPont Young Faculty Award in 1996. She was an invited lecturer at the American Chemical Society/Optical Society of America 1996 Annual Meeting in Orlando, Florida, and at the Mario Molina Symposium on Chirality, also in Florida. Other invited lectures include the Eighth Annual Symposium for the Center for Photoinduced Charge Transfer, the 1997 Gordon Research Conference on Organic Thin Films, and the New England Chapter of the Electrochemical Society.

Professor T. Alan Hatton organized and chaired an Engineering Foundation Conference on "Structured Fluids and Interfaces: Technical Applications and Opportunities for Organized Molecular Assemblies" (January 1997) and is serving on the organizing committee of the Engineering Foundation Conference on Separation Technology (October 1997). He was an invited speaker and session chair at the Second Joint AIChE/CIESC Chemical Engineering Conference in Beijing (May 1997). He is the US Editor for Colloids and Surfaces A, and a section editor and editorial board member for Current Opinion in Colloid and Interface Science. Professor Hatton is on the Advisory Board for the Chemical Engineering Practice School program of the King Mongkut Institute of Technology Thonburi, in Bangkok, Thailand.

Professor Klavs F. Jensen became the Lamot duPont Professor of Chemical Engineering. He was an invited plenary lecturer at the International Conference of Chemical Vapor Deposition, the American Vacuum Society Meeting, the First International Conference on Microchemical Reactors, and the European Workshop on Metalorganic Vapor Phase Epitaxy. In collaboration with the DuPont Company and Professor Schmidt (EECS), Professor Jensen's group has fabricated and demonstrated microfabricated chemical systems.

Professor Paul E. Laibinis received a Young Investigator Award from the Office of Naval Research and a Presidential Early Career Award for Scientists and Engineers at a White House ceremony for his work on self-assembling systems. In 1997, he jointly developed a new "Colloids and Surfactant Science" course with Professors Blankschtein and Hatton.

Professor Robert S. Langer was awarded the Gairdner Foundation International Award, the William H. Walker Award (American Institute of Chemical Engineers), the Wiley Medal (U.S. Food and Drug Administration), and the Killian Faculty Achievement Award (MIT). Professor Langer was the Rohm Lecturer in Materials Chemistry (University of North Carolina) and gave Plenary Lectures at the 3rd Jerusalem Conference on Pharmaceutical Science and Clinical Pharmacology, the 3rd Cornell Symposium on Biotechnology, the Tissue Engineering Society Inaugural Meeting, the NSF Workshop on Interdisciplinary Macromolecular Science and Engineering, and the 1997 Congress on In Vitro Biology. He gave Keynote Lectures at the 3rd New Jersey Conference on Biomaterials and the First University of Michigan Whitaker Symposium on Biomedical Engineering. Dr. Langer received honorary Doctorates from both the ETH (Zurich, Switzerland) and the Technion (Haifa, Israel).

Professor Douglas Lauffenburger, also Director of the MIT Center for Biomedical Engineering, is serving as President of the Biomedical Engineering Society. In this past academic year he presented the Britton Chance Distinguished Lecture in Biomedical Engineering at the University of Pennsylvania and the keynote presentation at the annual Houston Conference on Biomedical Engineering.

Professor Gregory C. Rutledge was co-organizer and speaker at the International Symposium on Structural and Dynamic Modeling of Mechanical Behavior of Solids in Ascona, Switzerland. He gave invited talks at ANTEC '97, the annual meeting of the Society of Plastic Engineers, and at the 7th Hitachi/MIT Symposium on Computational Modeling of Materials and Processes. He also presented invited lectures at the University of Wisconsin, Pennsylvania State University, Tulane University and Johns Hopkins University. His development of novel uses of electronic media for enhancing education was featured in "Using New Technologies in the Classroom", a part of the Better Teaching at MIT series. Professor Rutledge currently serves on the Editorial Advisory Board of the journal *Polymer*.

Professor George Stephanopoulos was elected as the Chairman of the "Computing and Systems Technology" Division of the American Institute of Chemical Engineers for 1997. Professor Stephanopoulos presented invited lectures at Rohm and Haas, Searle, Abbott Labs in the US, Bayer (Leverkusen, Germany), Akzo Nobel Co (Arnhem, Netherlands), Zeneca (Huddersfield, UK), and Mitsubishi Chemical Corporation (Japan). He also gave a series of guest lectures at Kyoto University. He was appointed Honorary Fellow at the Institute of Chemical Engineering, Patras, Greece. Professor Stephanopoulos was the International Programming Committee chairman for ESCAPE-6, "European Symposium of Computer-Aided Process Engineering" (Rhodes, Greece, May 1996). Academic Press published the paperback edition of his book on "Intelligent Systems in Process Engineering", which contains work he carried out at MIT with his students over the last eight years.

Professor Gregory Stephanopoulos received the AIChE FPBE Division Award for 1997. He gave the inaugural Bayer lecture on Biochemical Engineering at UC Berkeley, a keynote lecture at the Cell Culture Engineering Conference in San Diego, and an invited lecture on Metabolic Fluxes and Metabolic Engineering at the Volkswagen Symposium in Hannover, Germany. In the Fall of 1996 he chaired the first Engineering Foundation Conference on Metabolic Engineering which was attended by more than 200 participants and inaugurated this new conference series. Among his other writing projects, he just finished his book on Metabolic Engineering to be published by Academic Press and started a new journal on the same subject scheduled to appear next spring.

Professor Daniel I.C. Wang was a keynote lecturer at the Recovery of Biological Products held in Tucson, AZ in October, 1997. Professor Wang delivered this lecture entitled "Awakening of the Dragon: Biotechnology in the

People's Republic of China." Professor Wang also delivered the opening lecture at the Biochemical Engineering Conference X at Kananaski, Canada, in May 1997 entitled "The Role of Biochemical Engineering in the New Biotechnology." Professor Wang also participated in the MIT Industrial Performance Center's project where he led the biotechnology team resulting in the book entitled "Made By Hong Kong" which was published in April, 1997. Professor Wang was appointed as the Chairman of the Biotechnology Strategic Review Board in April, 1997 for the Republic of China. Professor Wang has also been invited to be on the International Advisory Committee of the Biotechnology Research Institute of the Hong Kong University of Science and Technology.

Professor Jackie Ying was recognized by the American Chemical Society with the 1997 Award in Solid State Chemistry for her research on synthesis and catalytic properties of nanocrystalline non-stoichiometric catalysts, derivation of a novel class of transition metal oxide molecular sieves, and structure and properties of layered transition metal molybdates. She delivered 13 invited lectures on nanostructured materials research at various international conferences and national meetings during the past year. Prof. Ying was the organizer of the 3rd International Conference on Nanostructured Materials, the Ceramics Processing Topical Conference at the 5th World Congress of Chemical Engineering, and the Symposium on "Sol-Gel Synthesis of Catalysts and Advanced Materials" for the ACS National Meeting. She was recently appointed to the Editorial Boards of Nanostructured Materials and Journal of Electroceramics, and is guest editing a special volume on "Sol-Gel Derived Materials" for Chemistry of Materials and a special volume on "Advanced Ceramic Processing" for the AIChE Journal.

RESEARCH HIGHLIGHTS

MODELING, SIMULATION, AND OPTIMIZATION OF PROCESS DYNAMICS

Understanding and manipulation of dynamic phenomena are crucial to the engineering of chemical processing systems. Professor Paul Barton's laboratory is conducting a broad program of research unified by the themes of modeling, simulation, and optimization of large-scale dynamic systems. Application areas include process design, process operation, process safety, and pollution prevention.

Of particular interest are dynamic systems that exhibit coupled discrete and continuous behavior (or hybrid dynamic systems). Examples include the interaction of a chemical plant and its emergency shutdown system, or the detailed sequencing of batch manufacturing operations. Recent highlights include new theoretical results that enable dynamic sensitivity analysis of a very broad class of hybrid systems, and the development of a novel numerical algorithm for sensitivity analysis of large-scale dynamic systems that can yield order of magnitude reductions in solution times. Codes implementing these advances are being made available through the Technology Licensing Office. In addition, his group developed preliminary results on algorithmic approaches to dynamic optimization of hybrid systems and mixed integer dynamic optimization.

Another thrust area is the development of technologies that can lead to safe process designs, and reduce risk in process operations. This research has recently led to the development of Implicit Model Checking, a technology for the formal verification of emergency shut-down system designs with respect to formal functional specifications. Implicit Model Checking exhibits its primary advantages in formal verification of large-scale coupled systems, where a novel and compact model formulation makes tractable previously inaccessible problems. This technology is currently being patented through the Technology Licensing Office.

June 1997 marked the official start of the ABACUSS Project in Professor Barton's laboratory. This is a major collaborative effort with industry to develop the a new generation of equation-based simulator technology.

FUNDAMENTAL AND APPLIED TISSUE ENGINEERING

Advances in cell biology and materials science, combined with severe clinical needs, have spurred the development of the new field of "tissue engineering". Tissue engineering relies on the manipulation of cells using biochemical factors, synthetic materials, and mechanics to form complex multi-dimensional structures that carry out the functions of normal tissue in vitro or in vivo. Work in the lab of Prof. Linda Griffith focuses on controlling the spatial and temporal presentation of molecular ligands and physical cues which are known to influence cell behavior, and spans the molecular/cellular to tissue/organ level. The major application is recreating liver tissue for transplantation or in vivo drug metabolism testing.

Control of cell behavior at the molecular level is achieved by "tethering" ligands for cell surface receptors to insoluble components of the cellular environment, providing a novel way to control delivery of growth factors and to direct interactions between cell growth factor receptors and cell adhesion receptors. This strategy, in addition to providing a facile way to modify applied biomaterials to achieve the desired cell functions, provides a new tool for cell biologists, allowing many studies of receptor function to now be carried out on normal cells rather than mutants and transformed cell lines. This tethering approach is currently being adapted to provide bio-specific functionality in a new enzymatically-crosslinked hydrogel developed in Prof. Griffith's lab, with an eye toward improving therapies for treating diabetes and arthritis. Prof. Griffith's lab is integrating multiple aspects of cell behavior at the molecular level to generate macroscopic 3D tissues, with a current emphasis on developing perfused microvascular tissues in vitro. A solid free-form fabrication technique is used to generate complex 3D scaffolds from degradable polymers, and principles of biophysics are used to achieve tissue morphogenesis in the devices. This technology has the potential for greatly improving in vitro assays of drug metabolism, and may ultimately allow replacement of animal testing in the pharmaceutical industry.

MOLECULAR ENGINEERING OF INTERFACIAL PROPERTIES

The advent of recent developments in chemistry, physics, and materials science has expanded our ability to tailor and characterize materials at the molecular level. Professor Paul Laibinis' group is applying these methods and developing others as means for tailoring interfacial properties in areas as diverse as corrosion prevention, protein adsorption, semiconductor modification, and sensor design. Self-assembly is used to generate adsorbed molecular films of tailored organic composition onto a wide variety of metal and metal oxide substrates. Adsorbates have been developed that will spontaneously adsorb onto copper surfaces and form densely packed, oriented films that limit diffusion of corrosive molecules to the underlying copper substrate. The crystalline nature of the resulting films provides barrier films that are many orders of magnitude better in inhibiting corrosion than simple polymeric coatings of similar thickness.

Prof. Laibinis' laboratory is also investigating new platforms and strategies for the generation of multi-analyte sensors. Electroplating methods that deposit a single layer of a dissimilar metal onto an electrode surface have been employed to improve adhesion at electrode/organic interfaces. This strategy appears to maintain the electrical utility of the electrode material while incorporating the stability associated with bulk amounts of the electrodeposited monolayer metal. Robust organic coatings for glasses and metal oxides have also been produced that exhibit useful stabilities and high levels of resistance against non-specific protein adsorption. These coatings form by a self-assembly process to expose ethylene oxide units and should have use in biosensor technology where background signals need to be minimized and various biochemical and biomedical applications.

DEPARTMENTAL AWARDS

The Chemical Engineering Department's annual Awards Ceremony was held on Wednesday, May 14, 1997 in the Gilliland Auditorium with Professor and Department Head Robert C. Armstrong presiding. The following awards were presented:

In conjunction with the Student Financial Aid Office, Amoco Foundation Undergraduate Scholarships were acknowledged for recipients Celeste M. Nelson, a junior from Denver, CO, Kum Ming N. Woo, a junior from Kaneohe, HI, and Elaine H. Wong, a senior from Kowloon, Hong Kong.

The Dow Chemical Company Outstanding Junior Award recipient was Tiffany P. Cunningham, a junior from Bloomfield Hills, MI, for her balanced record of achievement in academics and campus professional and social organizations, as well as work experience.

The Robert T. Haslam Cup was awarded to Robert J. Meagher, a senior from Sterling Heights, MI, for outstanding professional promise in chemical engineering.

The Roger de Friez Hunneman Prize, the oldest prize in the department (begun in 1927), was awarded to H. Frank Greer, a senior from Burlington, Ames, IA, in recognition of outstanding scholarship and research.

The Edward W. Merrill Outstanding Teaching Assistant Award was presented to Michael S. Wong, a graduate student from Sacramento, CA, for excellence in teaching in an undergraduate subject. A second place award went to Wendy S. Koegler, a graduate student from Richland, WA.

Chemical Engineering Department Special Service Awards were given to Randall T. Myers, a graduate student from Wilbraham, MA, Jennifer T. Fujii, a graduate student from Sunnyvale, CA, and Laura L. Walker, a senior from Holyoke, MA, for their unselfish contributions to the success of departmental activities.

The Chemical Engineering "ROCK" Award for outstanding athletics, as voted by the graduate students of the department, went to Randall T. Myers (see above).

The Outstanding Employee Award was presented to Francine Chaput, a Senior Office Assistant in the ChemE/DMSE Administrative Services Center, for her exceptional service to the department and its students.

The Outstanding Faculty Award from the graduate students, was presented to Professor William M. Deen. Undergraduate students in the department presented an Outstanding Faculty Award to Dr. C. Michael Mohr.

Individual Accomplishment Citations were presented to Darlene Messmer-Slagle, of the ChemE/DMSE Administrative Services Center, and to Bradford D. Ricketson of Birmingham, AL, for their outstanding contributions to departmental life. Ricketson and Messmer-Slagle were recipients of the second offering of this special award, and each received a personalized citation signed by the Department Head.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/communications/pres96/10.02.html>

Robert C. Armstrong

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

The Department's Strategic Plan is founded on the three pillars of infrastructure, environment and information/management systems. We seek to educate the leaders and innovators of the profession. We seek discovery, innovation and the development of new behaviors, technologies, and methods that improve the practice of civil and environmental engineering. Our Strategic Plan was revised last year and defines new short term Action Items. They are: (1) carry out a full revision of the undergraduate curriculum; (2) further develop the M.Eng. program; (3) develop a strategy to increase fellowship support for graduate students; (4) study the feasibility and embark, if possible, on creating a series of textbooks using the latest in multimedia and information technology; (5) continue aggressive efforts to attract outstanding minority and women faculty hires to build on our past successes; (6) develop mechanisms which will permanently finance continuing improvements in computer facilities, technical support and laboratories; (7) develop a feasibility study for a new environmentally friendly and unified building for CEE; (8) complete our faculty salary hardening initiative; (9) review our organization seeking further reduction in bureaucracy and improvements in communications and cooperation; (10) develop a plan for international initiatives in education and research; (11) create mechanisms to develop a closer relationship to industry.

This past year we made significant progress on several items. The rest of this report summarizes those accomplishments.

The Department re-organized in three groups: Environmental Systems, Engineering Systems, and Engineering and Environmental Mechanics. These groups embrace and supersede the traditional disciplines of Civil and Environmental Engineering. The Department facilities are still divided between the Ralph M. Parsons Laboratory and the Henry L. Pierce Laboratory.

Three new educational computer facilities were developed in collaboration with MIT's Information System (IS). The client-server architecture using Windows NT as the operating platform is a test bed and experiment for IS and a possible new model in the post-Athena era.

CEE inaugurated the Design Studio for the Future facilities. This modern teaching environment serves undergraduate and graduate education and builds on a collaboration with the School of Architecture and Planning and the Department of Mechanical Engineering.

Faculty salaries are almost completely hardened, i.e., fully budgeted for the 9-month academic year. Our soft money (sponsored research) dependence over the academic year is down to less than 2.5% of faculty salaries.

UNDERGRADUATE EDUCATION

CEE just completed and approved a major revision of the undergraduate Civil Engineering degree. The goal is to put this new concept into effect by the fall of 1998. The new program provides increased flexibility for students to specialize in the area of system engineering, environment or mechanics. There is considerable new emphasis on design and laboratory experiences throughout this career.

A revision of the Environmental Engineering Science degree is on-going.

Undergraduate enrollment remains stagnant (see Table). We are confident that our new initiatives will be more attractive to MIT undergraduates.

GRADUATE EDUCATION

The second class of 32 M.Eng. students graduated this past June. The program continues to improve and is a success. Students are being actively recruited. Our goal is to make this program increasingly attractive to those interested in professional practice and a seamless alternative of graduate education for our undergraduates. Next year we expect another 30 or so students.

As called for in our Action Items, next September we open a new track of study: High Performance Structures. Already 8 new students are enrolled in this option.

**Department of Civil and Environmental Engineering
Enrollment 1991-1997**

| Year | Faculty | Undergraduate Students | Graduate Students | Yearly Total |
|---------|---------|------------------------|-------------------|--------------|
| 1996-97 | 34 | 107 | 305 | 412 |
| 1995-96 | 39 | 114 | 290 | 404 |
| 1994-95 | 35 | 120 | 285 | 405 |
| 1993-94 | 37 | 134 | 301 | 435 |
| 1992-93 | 37 | 119 | 280 | 399 |
| 1991-92 | 36 | 113 | 304 | 417 |

**Department of Civil and Environmental Engineering
Graduate Degrees 1991-1997**

| Year | M.Eng. | Master of Science | Civil Engineer | Ph.D./Sc.D. | Yearly Total |
|---------|--------|-------------------|----------------|-------------|--------------|
| 1996-97 | 30 | 92 | 0 | 20 | 142 |
| 1995-96 | 21 | 98 | 1 | 22 | 142 |
| 1994-95 | | 93 | 1 | 33 | 127 |
| 1993-94 | | 101 | 1 | 21 | 123 |
| 1992-93 | | 83 | 3 | 23 | 109 |
| 1991-92 | | 80 | 3 | 29 | 112 |

Graduate education remains healthy. Enrollments and degrees awarded have been increasing. There is concern about apparent softening of the interest of good U.S. citizens on graduate education, particularly in traditionally strong areas like the environment.

We received over 3000 inquiries and some 405 applications for next fall admission.

FACULTY NOTES

Drs. Kevin Amaratunga and Martin Polz have accepted offers and will join the faculty for next academic year.

Professors Daniele Veneziano and Andrew Whittle enjoyed sabbatical leaves this year.

Dr. Eric Adams is heading a new interdisciplinary project through Sea Grant looking at capping of contaminated marine sediments; the project is motivated by the Boston Harbor Navigation Improvement Project, which will begin later this year.

Professor Cynthia Barnhart was the President of Inform's Forum on Women in OR/MS; chaired the NSF Planning Committee for a Workshop on Transportation; and chaired the Membership Task Force, Transportation Science Section.

Professor Moshe Ben-Akiva and his research team at the Intelligent Transportation Systems (ITS) Program continue to operate with much success. The ITS Program's microscopic traffic simulator known as "MITSIM" was a winner of *Discover Magazine* Awards for Technological Innovation. Professor Ben-Akiva was awarded the Edmund K. Turner Professor of Civil and Environmental Engineering in September 1996.

Professor Rafael L. Bras is the faculty advisor of the new MIT Society of Graduate Fellows for Sustainability. He is a newly appointed editor of *Nonlinear Processes in Geophysics* and associate editor of *The Journal of Geophysical Research-Atmospheres*.

Professor Oral Buyukozturk is on the Swiss Government's two visiting Committees to evaluate the research and educational programs of ETH in the area of materials science. Professor Buyukozturk delivered the keynote address

entitled "Imaging of Concrete Structures" at the International Conference on NDT in Civil Engineering held in Liverpool, England.

Professor Ismail Chabini was awarded the Gilbert Winslow Career Development Chair.

Professor Sallie Chisholm received the Guggenheim Fellowship for her work on the science and policy aspects of Ocean Fertilization.

Professor Jerome Connor won the Effective Teaching Award. The Los Angeles Tall Buildings Structural Design Council has named C.C. Pouanger and Professor Connor winners of their Outstanding 1995 Journal Paper Award for "New Structure Systems for Tall Buildings: The Space-Truss Concept".

Professor Patricia Culligan was awarded a Esther and Harold E. Edgerton Assistant Professorship. She continued to develop the Geotechnical Centrifuge Modeling Facility in the Department by the commission of a mini-drum centrifuge, which is the only centrifuge of its kind in North America.

Professor Richard de Neufville has served in the Visiting Committees of the Technical University of Delft, University of Utrecht, and Technical University of Eindhoven.

Professor Peter S. Eagleson is the winner of the 1997 Stockholm Water Prize for "single-handedly elevating hydrology to the level of a major scholarly science".

Professor Dara Entekhabi was awarded tenure this year. He received the prestigious Macelwane Award of the American Geophysical Union.

Professor Herbert Einstein's seven year effort to significantly change engineering education received in-house acceptance through a major revision of the Civil Engineering undergraduate curriculum.

Professor Elfatih A. B. Eltahir's was honored with the prestigious Young Investigator Award from NASA. His research on the potential link between deforestation and droughts in West has received broad attention in the popular and scholarly scientific arena.

Professor Lynn W. Gelhar served on expert panels reviewing technical aspects of risk/performance assessments for Department of Energy's Nevada nuclear weapons testing site and the proposed low activity tank waste disposal at Hanford, Washington. He is also serving on an expert panel reviewing hydrogeologic aspects of the proposed high level radioactive waste disposal facility at Yucca Mountain, Nevada.

Dr. John Germaine was elected Second Vice Chairman of ASTM Committee D18 on Soil and Rock.

The first person to hold the newly endowed Matoula S. Salapatas Professorship in Materials Science and Engineering is Professor Lorna Gibson, who has a joint appointment in CEE and ME.

Professor Philip Gschwend was appointed Ford Professor of Engineering.

Professor Harry Hemond was named William E. Leonhard Professor of Civil and Environmental Engineering. He has just signed a publishing agreement for a new edition of the textbook, *Chemical Fate and Transport in the Environment*, co-authored with CEE alum Elizabeth Fechner-Levy.

Professor Eduardo Kausel has been named Fellow of ASCE and Honor Faculty Member of Chi Epsilon, the National Civil Engineering Honor Society. He is now co-editor of a new series of books on earthquake engineering.

Professor Charles Ladd, John Christian '58, '59, '66 and Gregory Baecher '70 and '72 were recently given the Thomas A. Middlebrooks Award by the ASCE at its annual convention in Washington. The award recognizes their paper, "Reliability Applied to Slope Stability Analysis" in the *Journal of Geotechnical Engineering*, December 1994.

Professor Steven R. Lerman continues as the Director of the MIT Center for Educational Computing which merged at the start of this year into the newly-created Center for Advanced Educational Services. Starting June 15, 1997, he will be the Associate Chair of the MIT Faculty.

Professor Christopher Leung became associate editor of ASCE's, *Journal of Infrastructure Systems*, and ASCE's *Journal of Materials in Civil Engineering*.

Professor Ole S. Madsen spearheaded, as Chair of the Department's Undergraduate Committee, the revision of the I-C Undergraduate Program's Curriculum. Professor Madsen is the 1997 recipient of the Samuel M. Seegal '22 Prize, a prize designated for "that faculty member in business or in civil engineering, who more than any other, inspired students in pursuing and achieving excellence".

Professor David H. Marks continues in his leadership of CEE Masters of Engineering Degree. He continues his work as MIT Coordinator for the Alliance for Global Sustainability, Co-chair of MIT Council on Environment, Director of the MIT Program for Environmental Engineering Education and Research, and the environmental portion of the MIT Ford Partnership.

Professor Dennis B. McLaughlin was honored with the H.M. King Bhumipol Professor Chair which honors the monarch of Thailand.

Professor Chiang C. Mei was appointed Head of the new Engineering and Environmental Mechanics Group in the Department. He also chaired and helped organize a workshop on Mechanics in Modern Science and Technology in Taipei, April 26-28, 1997, with a view to establishing a Research Institute of Mechanics in Academia Sinica (Chinese Academy).

Professor John Miller completed ten case studies addressing project delivery and finance of large complex public infrastructure projects in the United States and Canada. The case studies serve as curriculum development materials and as part of his ongoing research into new approaches for long term delivery of sustainable infrastructure portfolios.

As director of the Technology and Development Program, Professor Fred Moavenzadeh has been leading MIT's thrust into international research and education.

Professor Heidi Nepf won an NSF Career Award for her work in wetland hydrodynamics. She also won the Department's Effective Teaching Award. She was a visiting scholar at the Centre for Water Resources at the University of Western Australia during May and June 1997.

Professor Feniosky Peña-Mora received a fellowship from the Marion and Jaspe Foundation to spend a month in the University of Sidney, Australia, working on research in collaborative negotiation methodologies. Professor Peña-Mora is also the recipient of the Gilbert W. Winslow Career Development Chair and an award from the James H. Ferry Jr. Fund for Innovation in Research.

The Center for Technology, Policy and Industrial Development and its Director, Daniel Roos, continue to promote industrial research in the Institute. Professor Roos co-chaired the Provost's Council on Industrial Relations.

Professor Yossi Sheffi developed and shepherded the creation of a new Master of Engineering in Logistics.

Professor Sarah Slaughter was appointed to the National Research Council Committee on the Outsourcing of Design and Construction Management Services for Federal Facilities. She was awarded the Gilbert Winslow Career Development Chair Professor

Professor Joseph M. Sussman writes a column entitled "Thoughts on ITS" for the *ITS Quarterly*. He continues as chair of the Graduate Education and Admissions Committee.

Professor Bettina Voelker joined the faculty in 1996. In the spring term, she developed a new graduate course called Environmental Chemical Kinetics (1.761). She also co-chaired a symposium, The Role of Speciation in Trace Element Fate and Transport, at the American Chemical Society's spring meeting in San Francisco, April 13-17, 1997.

Professor Emeritus Robert V. Whitman was made an Honorary Member of the Earthquake Engineering Research Institute (EERI). He continued in his leadership role guiding the development of a new earthquake loss estimation methodology. The Federal Emergency Management Agency has now released to first version of the software (called HAZUS) for use by state and cities.

Professor Andrew Whittle and his former student, Yousef Hashash, will receive the 1997 Thomas A. Middlebrooks Award for the best paper published by ASCE in the field of Geotechnical Engineering.

Professor John Williams was awarded tenure.

Professor Nigel Wilson was appointed leader of the newly created Engineering Systems Group in the Department. A two year extension was approved for the collaborative research and education program between MIT and the University of Puerto Rico in support of the Tren Urbano project in San Juan. Nigel Wilson serves as principal investigator for this program which involves eight MIT faculty and fifteen graduate students.

Professor Shi-Chang Wooh received the Esther and Harold E. Edgerton Career Development Chair.

RESEARCH HIGHLIGHTS

CEE sees itself as a Hub Department and actively pursues interdisciplinary research via associated centers and other units and groups at MIT. Through the Technology and Development Program, our faculty is pursuing its international interests. We are involved in Argentina, Thailand, Malaysia, and Singapore. Through the Program of Environmental Engineering Education and Research, the Alliance of Global Sustainability, the Center of Environmental Health Science, and the Center of Global Change Science, we pursue large efforts related to the environment. The traditional involvement with the Center for Transportation Studies includes very successful and large activities in "intelligent transportation" and urban transportation, the latter in the form of the Tren Urbano, a research and education initiative in collaboration with the University of Puerto Rico. The MIT-Woods Hole Joint Program is the home of education and research in the ocean sciences and engineering for many of our faculty. Our long-standing interaction with Sea Grant continues.

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 Phoebe Lam '97, Christopher Marx '97, and Laurel Schaidler '97.

Christina Marsh '97 (1-C) received the Steinberg Prize given to an undergraduate with an excellent academic record and an interest in construction management.

Brigitte Burnell '98 (1-C) was first prize in the Parke A. ('27) and Ann. L. Hodges Award, for her paper entitled, *Coral Bleaching*.

Daeki Kim (1-C) with Professor Cynthia Barnhart won the best student paper award for "Multimodal Express Shipment Service" at 20th International Computer and Industrial Engineering Conference, Korea.

Winner of the 1996/97 National Student Award for Region One of the University Transportation Centers Program is Lisa Klein '97 (MST).

James Kennedy '97 received the Hugh Hampton Young Memorial Fellowship through the Graduate Education Office.

Joseph Mendoza '97, Gema Optiz '97, and Gregorio Cruz '98 won General Electric Foundation Grants for UROP work.

Orjan Gustafsson (1-C) won the American Chemical Society's Division of Geochemistry best student paper entitled "Soot as a Strong Partition Medium for Polycyclic Aromatic Hydrocarbons in Aquatic Systems".

The Effective Teaching Award for a TA was awarded to Santanu Das (1-C).

More information about the Department of Civil and Environmental Engineering can be found on the World Wide Web at the following URL: <http://WEB.MIT.EDU/CIVENV/>

Rafael L. Bras

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

During the past several years the Department has completed the implementation of its Master of Engineering (M.Eng.) program as the one that is recommended for undergraduate students who wish to pursue a career in engineering. Those who stop at the bachelor's level are well prepared for further study leading to careers in a variety of professions such as law, medicine, or public service. Those who continue on to the doctorate are well prepared for a career in research, teaching, scholarship, and other occupations where one has to understand what things are like on the frontiers of knowledge.

The M.Eng. program is a five-year program leading to the simultaneous award of bachelor's and master's degrees. At this time about two thirds of the Department's undergraduates continue to receive the M.Eng. degree. The curriculum is seamless between the traditional disciplines of electrical engineering and computer science, and is also seamless between undergraduate and graduate study.

The Department's bachelor's programs (there are three of them) received accreditation by ABET and CSAB. Two of the programs were previously accredited, and reaccreditation was anticipated. The third program, which had not been previously accredited, gives students a degree of flexibility not normally present in accredited programs. Nevertheless, this third program was not only accredited, but was even back-accredited so as to apply to all students who had graduated from the program in the past.

Undergraduate enrollment in computer science has grown dramatically in the past few years. Traditionally one third of the EECS undergraduates majored in computer science, and two thirds in electrical engineering. Recently the statistics have shown that about two thirds favor CS, and only one third EE. This trend is anticipated to continue. The Department must be prepared to shift the balance of its faculty to more closely approximate student interest. We will find this easier than many other universities where EE and CS are in different departments.

Overall enrollment in EECS continues to be high, and the students continue to be extraordinarily well qualified academically.

For the past two decades our computer science faculty and graduate students have had their offices and laboratories in a building that is off campus. This geographical barrier has tended to impede collaboration between CS faculty and those on campus, and has worked against the notion that the fields of EE and CS are really closely related and, indeed, can best be thought of as a single discipline. We are currently raising the money necessary to erect a new building on campus, adjacent to one of the laboratories housing many EECS faculty. The computer-science laboratories currently off campus (the Laboratory for Computer Science and the Artificial Intelligence Laboratory) will move into this building, along with the Laboratory for Information and Decision Systems. If the funds are raised promptly, construction could begin in 1998.

UNDERGRADUATE PROGRAM

Enrollment of undergraduates averaged 1000 in 1996-1997 with about 30 percent in the Electrical Engineering Program, 40 percent in the Computer Science Program, and 30 percent in the Electrical Engineering and Computer Science Program. From the Class of 1999, 370 students were enrolled in Course VI, up significantly from the preceding year. About 310 students from the Class of 1999 have so far selected Course VI, with only 16 percent choosing 6-1, 50 percent 6-2, and 34 percent 6-3.

The Master of Engineering (M.Eng.) program entered its fourth year with 250 students.

The following prizes and awards were won by our students:

The Ernest A. Guillemin Thesis Competition for outstanding performance on a Master of Engineering thesis in Electrical Engineering was won by Emilija Simic of Boston, MA, Abram P. Dancy of Merrimack, NH, and Pablo L. Narvaez-Guarnieri of Cambridge, MA.

The David Adler Memorial Prize for outstanding performance on master of engineering thesis in computer science was given to Steven E. Shaw of Mansfield, CT.

The Charles and Jennifer Johnson Thesis Prize for outstanding performance on Master of Engineering thesis in computer science was awarded to Matthew H. Fredette of North Andover, MA.

The Morris Joseph Levin Award-Best MasterWorks Oral Thesis Presentation Prize was awarded to Nimisha Mehta of Jackson Heights, NY, and David M. Murphy of Winchester.

The George C. Newton UG Lab Prize for the best undergraduate laboratory project as awarded jointly to Guang-Ien Cheng of Potomac, MD, Michael Sung of Woburn, MA, and Allen C. Sun of Gaithersburg, MD.

The Robert A. Fano UROP Award was given to M. Josephine Ammer of Cambridge, MA, Ekaterina Dolginova of Schenectady, NY, and Damian Megna of Northbridge, MA.

The Northern Telecom/BNR Project Awards were made to William A. Lentz of Las Cruces, NM, Calvin J. Lin of Cambridge, MA, Rex Min of Newport News, VA, and Alvar Saenz-Otero of Cambridge, MA.

The David A. Chanen Writing Award was given to Lukasz A. Weber of Indio, CA.

The Nylander Award Advanced UG Project was given to Grant I. Ho of Cambridge, MA.

The Department Heads Special Recognition Award was given to Nimisha V. Mehta of Jackson Heights, NY.

The Norman R. Carson Outstanding EE Junior Award - Eta Kappa Nu was given to Ashwin Viswanathan.

The Richard J. Caloggero Award was given to Anne M. Hunter, the administrator of the Department's Undergraduate and M.Eng. programs.

GRADUATE PROGRAM

In September, 1996 there were 792 graduate students enrolled in the department. About 20 percent of the total were foreign nationals. The department supported 430 Research Assistants and 109 Teaching Assistants. In addition, there were 170 fellowships including 55 National Science Foundation Fellows, and 27 Department of Defense Fellows. The remaining students had industrial or foreign support or were using their own funds.

During 1996, the department awarded 105 Master of Science degrees, 7 Electrical Engineer degrees and 69 Doctoral degrees.

The department received 1741 applications for the 1996-97 year, a slight decrease from 1995. The applications continue to be generally excellent and 268 were admitted for 1996 (February, June and September), of whom 123 registered in September.

A number of awards were made to graduate students for excellence in teaching. O. Patrick Kreidl of Somerville, MA, received the Carlton E. Tucker Award and Lon E. Sunshine of Framingham, MA, received the Harold L. Hazen Award. The Frederick C. Hennie III Awards for excellence in teaching were presented to James C. Hoe of Cambridge, MA, and Sean C. Warnick of Cambridge, MA. Kathleen E. Wage of Cambridge, MA, Patrick J. LoPresi of Brighton, MA, and Matthew Secor of Cambridge, MA, were promoted to Instructor-G in recognition of their demonstrated teaching ability and service to the department.

VI-A INTERNSHIP PROGRAM

In its 80th year, the department's VI-A Internship Program continues to maintain its popularity and excellent performance. This year 147 students applied during the annual orientation and selection process and 80 applicants were selected as members of the incoming VI-A class. In comparison, in 1996 161 students applied and 80 were selected. Since the last report, approximately 26 students have withdrawn from the VI-A Program. Some students felt the opportunities within the on-campus M.Eng. program better matched their needs. In spite of this trend, the Program

continues to provide excellent educational opportunities and the companies have ensured their commitment of challenging assignments.

The financial support for VI-A graduate students is also very good. Of the 28 VI-A companies in the Program, seven offer their own programs while 18 companies participate in the VI-A Fellowship program which pays one term MIT tuition while the student is working on a Master's thesis at a company, a stipend that is comparable to those available to on-campus assistantship and fellowship recipients, and medical insurance. Only three VI-A companies do not offer any VI-A graduate student support.

In June, 30 students received the M.Eng. degree having completed all their company assignments and Institute degree requirements. There were 35 students who were awarded their Bachelor's degree and most of them will continue into the graduate phase of the Program.

There were five additions to VI-A this spring: Hewlett-Packard added its LaserJet Division in Boise, ID; Lucent Technologies in NJ; PairGain Technologies in Tustin, CA; Silicon Valley Group with locations in Wilton, CT, and Orange and San Jose, CA; and Teradyne in Agoura Hills and San Jose, CA. The David Sarnoff Research Center and Motorola's Land Mobile Products Sector did not recruit students this year and Siemens ROLM has withdrawn from the Program. Other companies have expressed interest in participating, so the program size should remain constant.

At the annual Department Awards Reception held in the West Wing of the Museum of Science in Boston, the following VI-A students were honored. William A. Lentz was a recipient of the Northern Telecom/BNR Project Award; Michael Sung received a George C. Newton Undergraduate Laboratory Prize; Emilija Simic received an Ernst A. Guillemin Thesis Award; M. Josephine Ammer was one of the recipients of the Robert M. Fano UROP Award; and Grant I. Ho was the recipient of the Nylander Award Advanced Undergraduate Project.

At the 1997 Awards Convocation three VI-A students were among those honored. N. Katherine Merrilees was a recipient of the Malcolm G. Kispert Award; Novice M. Johnson was a recipient of the Albert G. Hill Prize and Grant I. Ho was awarded the Louis Sudler Prize in the Arts for his excellence as a violinist.

The School of Humanities, Arts, and Social Sciences named 26 sophomores and juniors as Burchard Scholars for 1997. Students are chosen who have demonstrated a commitment to the humanities and social sciences. Maya R. Said was one of the students so honored.

Excellence in scholarship continues amongst the students in the Program. Of the 94 students from the School of Engineering who were elected to Tau Beta Pi, the National Engineering Honorary, 12 were VI-A's and Eta Kappa Nu, the Course VI Honorary, elected 73 members of whom 27 were VI-A's. Fifty-five seniors were elected to MIT's Xi Chapter of Phi Beta Kappa this year. Included in the group of honorees were four VI-A students: Anthony J. Accardi, Debajit Ghosh, Kenneth S. Hon and Emilija M. Simic.

The 1996-97 Ilona Karmel Writing Prizes recognized the writing achievements of 24 students in the categories of essay, drama, poetry, short story, fiction, and scientific and technical writing. First place in the Boit Manuscript Prize for drama was awarded to Lawrence K. Chang for "Copper Spaghetti."

Eight students who made outstanding contributions to the cultural life of MIT were recognized at the annual Music and Theater Arts awards ceremony. Christopher H. Rohrs was a recipient of a Ragnar and Margaret Naess Award for exceptional talent and commitment to private performance study.

FACULTY

Five new faculty members joined the department this year:

Saman P. Amarasinghe, Assistant Professor of Computer Science and Engineering, received his Ph.D. at Stanford University.

John M. Chapin, Assistant Professor of Computer Science and Engineering, received his Ph.D. at Stanford University.

Leonard McMillan, Assistant Professor of Computer Science and Engineering, received his Ph.D. at the University of North Carolina.

Alexandre Megretski, Assistant Professor of Electrical Engineering, received his Ph.D. at Leningrad University and came to MIT from a faculty position at Iowa State University.

Rajeev J. Ram, Assistant Professor of Electrical Engineering, received his Ph.D. at the University of California, San Diego.

Associate Professors Jesús A. del Alamo and Jacob K. White were promoted to Professor. Assistant Professors Duane S. Boning, Steven B. Leeb, and Mitchell D. Trott were promoted to Associate Professor.

Honors and awards received by our faculty this year include:

Professor Dimitri A. Antoniadis was named Ray and Maria Stata Professor of Electrical Engineering.

Professor Dimitri P. Bertsekas received the Institute for Operations Research and Management Science Prize for his book *Neuro-Dynamic Programming and the Research Behind It*, coauthored with Professor John N. Tsitsiklis.

Professor Rodney A. Brooks was named Fujitsu Professor of Computer Science and Engineering.

Assistant Professor Anantha P. Chandrakasan was named Analog Devices Career Development Assistant Professor of Electrical Engineering.

Institute Professor Mildred S. Dresselhaus won the Sigri Great Lakes Carbon Award of the American Carbon Society.

Adjunct Professor G. David Forney was named Bernard M. Gordon Adjunct Professor. He also won the Cristoforo Colombo Award in International Communication and the Marconi International Fellowship for significant contribution to the advancement of the technology of communications.

Professor Shafri Goldwasser received the Grace Murray Hopper Award from the Association for Computing Machinery. She was also named RSA Professor of Computer Science and Engineering.

Professor Alan J. Grodzinsky received the Melville Medal of the American Society of Mechanical Engineers for the best original paper (“A Molecular Model of Proteoglycan-Associated Electrostatic Forces in Cartilage Mechanics”) across all fields of mechanical engineering.

Assistant Professor David R. Karger received an Alfred P. Sloan Foundation Research Fellowship.

Assistant Professor Steven B. Leeb won the Junior Bose Award for Excellence in Teaching. He was also named Carl Richard Soderberg Assistant Professor in Power Engineering.

Professor Barbara H. Liskov was named Ford Professor of Engineering.

Professor Tomás Lozano-Pérez was named Cecil H. Green Professor of Computer Science and Engineering. He also received the Department Head’s Special Recognition Award for his work on revising the department’s doctoral program.

Professor Nancy A. Lynch was elected a Fellow of the Association for Computing Machinery. She was also named NEC Professor of Software Science and Engineering.

Professor Alan V. Oppenheim was named a MacVicar Faculty Fellow. He was also named Ford Professor of Engineering.

Professor Stephen D. Senturia received the Department Head's Special Recognition Award for his work on revising the department's doctoral program.

Associate Professor Lynn A. Stein was named a Science Scholar at the Mary Ingraham Bunting Institute of Radcliffe College.

Professor Kenneth N. Stevens received the Frank E. Perkins Award for Excellence in Graduate Advising.

Assistant Professor Seth Teller received an Alfred P. Sloan Foundation Research Fellowship.

Professor John N. Tsitsiklis received the Institute for Operations Research and Management Science Prize for his book *Neuro-Dynamic Programming and the Research Behind It*, coauthored with Professor Dimitri P. Bertsekas.

Professor George C. Verghese received the Frank E. Perkins Award for Excellence in Graduate Advising.

Associate Professor Gregory W. Wornell was named Cecil and Ida Green Career Development Associate Professor.

The following faculty were on sabbatical for all or part of the year: Professors Sanjoy K. Mitter, Robert C. Berwick, Alan J. Grodzinsky, Charles G. Sodini, Jin A. Kong, Harold Abelson, Roger G. Mark, Silvio Micali and Associate Professor Martin A. Schmidt

The department hosted seven visiting faculty:

Professor James W. Demmel, from the University of California, Berkeley, hosted by Professor Alan Edelman.

Associate Professor Alan D. Fekete, from the University of Sydney, hosted by Professor Nancy A. Lynch.

Associate Professor Stephanie Forrest, from the University of New Mexico, hosted by Professor Rodney A. Brooks.

Associate Professor Vivek Sarkar, from the IBM Academy of Technology and Stanford University, hosted by Professor Arvind.

Assistant Professor Nir N. Shavit, from Tel Aviv University, hosted by Professor Nancy A. Lynch.

Associate Professor Katherine A. Yelick, from the University of California, Berkeley, hosted by Professors Charles E. Leiserson and John V. Guttag.

Assistant Professor Kenneth Yip, from Yale University, hosted by Gerald J. Sussman.

The following retired from the faculty this year: Professors Abraham Bers, Fernando J. Corbató, Alvin W. Drake, Shaoul Ezekiel, Lawrence S. Frishkopf, Robert G. Gallager, Leonard A. Gould, Alan L. McWhorter, Frederic R. Morgenthaler, Richard D. Thornton and Institute Professor Hermann A. Haus.

We note with sadness the death of Gordon S. Brown on August 23, 1996 at the age of 89. Professor Brown served as department head (1952-1959), as Chairman of the Faculty (1951-1952) and as Dean of Engineering (1959-1968). He was named Institute Professor in 1973. He earned three degrees at MIT and joined the faculty in 1939. He influenced the directions of engineering education more than anyone else in the past 50 years. He advanced his vision of an undergraduate education based on fundamental science--"engineering science"--which today forms the guiding principle behind most, if not all, engineering education at MIT and elsewhere.

Paul Penfield, Jr.

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

This past year has been an excellent one for the Department of Materials Science and Engineering. We were pleased to once again be ranked first in both undergraduate education and graduate education among the Departments of Materials Science and Engineering by *U.S. News and World Report*. We have maintained this ranking ever since this began eight years ago.

In spite of the more difficult research funding climate, the research volume of the department has been relatively constant during the past year, while the number of graduate students has decreased to 168. The undergraduate student population has dropped somewhat to 110. In June we awarded 30 bachelors degrees, 19 masters and 14 doctorates. Our program of offering fellowships to a large percentage of domestic applicants continues to provide us with an outstanding graduate student body; 59% of our entering graduate student class in September, 1996 were domestic.

The Graduate Program has evolved to a single General Examination for the department, rather than the six degree program examinations that we had previously. In addition, the faculty voted to increase the number of core graduate subjects from two to four. These include subjects on "Materials at Equilibrium," "Kinetics," "Mechanics," and "Electrical, Optical and Magnetic Properties of Materials." Each of these subjects was taught for the first time this past year.

During the past two years the department has assumed responsibility for the Archaeological Science Program at MIT. This program, which is home to two faculty, Professors Heather Lechtman and Dorothy Hosler, builds on the strong materials emphasis that was brought by Professor Cyril Stanley Smith '26 ML. This program has begun to flourish in the department with well over 150 students taking subjects in archaeology. We believe that this interface between archaeology and materials science is one of the strongest such programs in the world, and we hope that it will grow and prosper in its new home.

We are pleased to have added two new women faculty members to our ranks this year: Professor Caroline A. Ross and Professor Sandra L. Burkett.

Dr. Ross received the BA with first-class honors from Cambridge University (1985) in Materials Science and Metallurgy. She then continued at Cambridge for the PhD (1988), completing the work in three years on the topic of electro-migration of thin metal films. Following graduation she spent two years as a postdoctoral fellow at Harvard University, working on interdiffusion in electrodeposition multilayers, and in January, 1991 she became a research scientist at Komag, Inc., the leading merchant supplier of memory disks for magnetic storage devices. She arrived at MIT in February, 1997 as the first holder of the newly established Thomas Lord Career Development Assistant Professorship of Materials Science. Professor Ross researches the magnetic and mechanical properties of thin films used in magnetic storage media and recording heads. Current media are made with sputtered films 10-20nm thick. Designing high-end media requires a detailed understanding of the relation between film microstructure and magnetic and mechanical properties. She is interested in thin film structure and growth, and in the properties of interfaces between films, including diffusion and interface structures, and has worked on the control of film magnetic properties such as magnetic anisotropy and time-dependent magnetic behavior, and on mechanical properties of films including stress effects and tribology.

Professor Burkett received the AB with honors from Princeton University (1990) in chemistry, and the PhD in chemistry from the California Institute of Technology (1994). She spent two years at the University of Bath in England as a research officer and academic tutor in the School of Chemistry, working on developing new families of organically functionalized, ordered mesoporous silica materials and magnesium silicate clays with applications in organometallic chemistry, catalysis, and host-guest chemistry. In early 1997 Dr. Burkett was a visiting researcher in the Department of Chemical Engineering at the University of Delaware. She arrived at MIT on July 1, 1997, and assumed the title of John Chipman Assistant Professor of Materials Chemistry. This career development chair, honoring the late Dr. John Chipman, head of the Department of Materials Science and Engineering from 1946-1962, was established in 1985. In addition to being one of the department's foremost leaders, Dr. Chipman laid the foundation for modern steelmaking technology through his pioneering work on metallurgical thermochemistry, a field he created. Professor Burkett's area of research expertise focuses on novel ceramic structures for catalysts and

biomaterials. She investigates the interplay between organic and inorganic components in the synthesis of nanostructured inorganic and inorganic/organic hybrid materials. Building upon previous research on zeolite synthesis and biomineralization processes, she is interested in understanding the nature of inorganic/organic intermolecular interactions within a range of synthetic and natural materials, elucidating nanostructure/property relationships, and applying these principles to the design and synthesis of new materials and devices, including biomaterials.

Two senior faculty members in our department became the holders of endowed chairs during this past year. On July 1, 1997, Professor Michael J. Cima became the Sumitomo Electric Industries Professor of Engineering. The Sumitomo Professorship was established in 1992 through a \$2 million dollar gift by Sumitomo Electric Industries in order to make a vital and permanent contribution to the advancement of research and to the intellectual future of MIT. Professor Cima is the second DMSE professor to hold the Sumitomo Electric Industries Professorship in Engineering; Dr. Harry L. Tuller, Director of the Crystal Physics and Electroceramics Laboratory, was the first. Professor Cima's general area of research interests include: ceramics processing, studies of processes for the removal of binders from ceramic greenware, drying, novel powder forming methods, ceramic thin films, and ceramics manufacturing. He is the author or co-author of over 100 scientific publications, holds six patents, and is a recognized expert in the field of ceramics manufacturing. He is also known for his work on growth of epitaxial oxide films by chemical methods and by ion-beam assisted deposition.

We are grateful to have received two newly endowed professorships created in August, 1996 through a \$4 million dollar gift from Dr. Vasilios S. Salapatas, an MIT alumnus and the managing director of Helliniki Halyvourgia, S.A., of Athens, Greece. The professorships are the Stavros V. Salapatas Professorship and the Matoula S. Salapatas Professorship, named in honor of Dr. Salapatas's deceased parents. These gifts are intended to strengthen the department and its teaching and research programs. On January 1, 1997, Professor Lorna Gibson became the first holder of the Matoula S. Salapatas Professorship in Materials Science and Engineering. Professor Gibson is a leader in the area of modeling and characterization of the mechanical behavior of cellular materials. During the past year her research has involved investigation of ultralight structures using metallic foams, and on progressive damage resulting from osteoporosis in trabecular bone. She has published more than 50 technical articles on the mechanical properties of materials with cellular structure, and is co-author with Professor Michael F. Ashby of the book, *Cellular Solids: Structure and Properties*. The book has been published by Cambridge University Press as part of their Cambridge Solid State Science Series. The holder of the Stavros V. Salapatas chair has not been announced.

In addition to the two Salapatas endowed professorships, the department has received a second junior faculty career development grant from the Lord Foundation of Massachusetts. This will create a second Thomas Lord Career Development Chair.

During the past year several members of the department have been instrumental in creating a Memorandum of Understanding between the University of Alaska and MIT. This agreement was signed on June 16, 1997. The purpose of the agreement is to collaborate in research and education which will develop new technologies to create employment in remote complex regions of the country. The initial response to this Memorandum of Understanding has been very encouraging both in Alaska and in Congress. It is hoped that this initiative will grow and develop into a major research program, not only for this department, but for several other departments within the School of Engineering.

In addition, during the past year the department teamed with the Department of Chemical Engineering to create the first Administrative Cluster at MIT. We were disappointed to lose Brian E. Tavares as one of the leaders of this cluster during the middle of the year, but have been quite fortunate in retaining the services of Elizabeth D. Cooper, who joined the department on April 1 as the Administrative Director of the Administrative Services Organization for the two departments. We hope that this Administrative Services Organization will provide enhanced services for both departments. Elizabeth came to the ASO from her former position as Administrative Officer of the Physics Department where she was in charge of educational as well as administrative management. Elizabeth earned an Ed.D. from the University of Rochester and brings an in-depth knowledge of higher education issues to this challenging position. One of her more recent posts was as an Associate with Coopers and Lybrand where she provided consulting services to education and not-for-profit clients in the areas of financial management, revenue

management, indirect cost, business process re-engineering, administrative management, planning and organization. This background will prove invaluable as she serves the changing needs of the cluster, the School and the Institute.

In addition to the other changes brought about by clustering, during the past year Professor Edwin L. Thomas stepped down as Associate Department Head, and Professor David K. Roylance became the departmental Executive Officer. The Executive Officer position is a new one for the department, and was created to develop some symmetry between the departmental organization of our department and the Chemical Engineering Department.

In May of 1997 we were pleased to dedicate an oil portrait of Professor Morris Cohen. This was a wonderful event attended by both family and friends of Professor Cohen. Morris was deeply touched by the event. In addition to this portrait, the department has commissioned portraits of John Chipman, John Elliott, and Richard P. Simmons, each of whom, along with Morris Cohen, has an endowed professorship named after them in the department.

Our faculty members continue to occupy a number of important leadership positions at MIT. Professor Vander Sande is Associate Dean of Engineering, Professor Kimerling serves as Director of the Materials Processing Center, Professor Rose continues as Director of the Concourse Program, Professor Roylance serves as Executive Officer, Professor Rubner serves as Director of PPST (Program in Polymer Science and Technology), Professor Allen serves as Secretary of the MIT Faculty, Professor Latanision continues as Chairman of the MIT Council on Primary and Secondary Education, and Professor Lechtman is Director of the Center for Materials Research in Archaeology and Ethnology.

UNDERGRADUATE EDUCATION

Although there has been a small decline this past year, our undergraduate enrollment remains at historically high levels. Essential to maintaining our undergraduate body are extensive recruiting efforts including a three day Open House, our annual John Wulff Lecture, direct mailings to the freshman class, Freshman Advisor Seminars, and IAP Activities. Our III-B Internship Program continues to attract the majority of the undergraduate students in our department. Through this program we have strengthened our interactions with 38 companies and government laboratories in the U.S., Europe, and Asia while providing summer experiences relevant to the educational development of our undergraduates. Our undergraduate body currently comprises 51% women, 15% underrepresented minorities, and 3% international students.

Professor David C. Dunand had been instrumental in organizing the Materials Undergraduate Study Exchange Program (MUSE) in 1995, and in signing agreements to establish the undergraduate exchange program with KTH Stockholm, ETH Zurich and, the Ecole Nationale Supérieure des Mines de Paris during academic year 1995-1996. Due to the fact that Professor Dunand took a leave of absence to Northwestern University, Professor Lorna Gibson took over as chair of the Undergraduate Study Abroad Program Committee, and she has continued the work begun by Professor Dunand. The department sent the first students abroad under this program last year.

The Student Undergraduate Materials Society (SUMS) continued to be a source of strength for the undergraduate program. SUMS assisted in end-of-term subject evaluations, assisted in the organization of the UROP Open House, sponsored seminars by departmental faculty members, planned socials, and assisted in tutoring of fellow students. Officers of the society during the spring and fall semesters of 1996 were: William P. Chernicoff (President), Mary E. Hamilton (Vice President), Neil T. Jenkins (Secretary), and Kim Marie Levis (Treasurer). New officers elected in the spring of 1997 are: Kim-Marie Levis (President), Ryan Cush (Vice President), Chelsea Russell (Secretary), and June Cheng (Treasurer).

GRADUATE EDUCATION

Approximately 22% of our graduate students are women and 2.9% are underrepresented minorities. The distribution of students among our six graduate degree programs and their affiliates is little changed from last year. As of February, 1997 it was:

| Degree Program | Percent of Total Graduate Students |
|-----------------------|-------------------------------------------|
| Ceramics | 8.5% |
| Electronic Materials | 27% |

| | |
|-----------------------|-----|
| Materials Engineering | 27% |
| Materials Science | 10% |
| Metallurgy | 9% |
| Polymers | 18% |

Five of our students in Materials Engineering were enrolled in the Technology and Policy Program, and four were enrolled in the Leaders for Manufacturing Program. Fifteen of our Polymer students were enrolled in the Program for Polymer Science and Technology. We anticipate for the fall of 1997 a total graduate class of about 175. The program we adopted five years ago of offering one-term fellowships to a large percent of domestic applicants has been successful. We estimate we will register an incoming class of 46 for the coming fall, over 59% percent of which will be domestic.

Nearly all undesigned 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, and the Department Endowed Fellowship).

Our endowed fellowships now provide sufficient annual income for one-term fellowships for approximately 12 students. In addition to the above, we are the grateful recipients of a number of grants from corporations and foundations to aid our first year students. We have received a large grant from the Starr Foundation which has provided up to four fellowships each year for a three year period, as well as a fellowship from the Lord Foundation of Massachusetts. These have been instrumental in assisting us to maintain the size and quality of our incoming domestic student class. We have fellowship support from a number of corporations including TECHINT and SIDOR. Of course, many students have other outside fellowship support as indicated elsewhere in this report. Of the 27 domestic students expected to enter in the fall of 1997, 14 will be entering on fellowships from the department and from a variety of sources including; NSF, DOE, DOD, NDSEG, FCAR, and the Air Force.

In 1996 the GMC voted to revise its officer organization during academic year 1996-1997 by forming a Core Committee with Erika Abbas as Chair. Officers of the Graduate Materials Society (GMC) Core Committee during academic year 1996-1997 were: Vanessa Chan, T.A. Venkatesh, and Phil Soo. Other officers during academic year 1996-1997 were: Valarie Benezra (Treasurer), Srikanth Samavedam and T.A. Venkatesh (MESSEminar Co-Chairs), Nicole Lazo (DCGS Representative), Olivera Kesler (GSC Representative), Kevin Eberman (Social Chair), and Ram Ratnagiri (Athletic Chair). GMC sponsored seminars, monthly socials and an end-of-the-year barbecue. The group continued to undertake the supervision of the arduous but important task of course evaluations. Newly elected Officers of the Graduate Materials Society (GMC) for academic year 1997-1998 are: Philip Soo (President), Debra Lightly (Vice President), Vab Andleigh (MESSEminars), Matthew Rosenthal (Treasurer), Eric Wu and Todd Stefanik (Athletic Chairs), Steven Murray and Christopher Vineis (Social Chairs), Michael Groenert and Nicole Lazo (DCGS Representatives), and Matthew Farinelli and Olivera Kesler (GSC Representatives).

Officers of the MIT Student Chapter of the Materials Research Society during the academic year 1996-1997 were: T.A. Venkatesh (Chair), Valarie Benezra (Treasurer), and Kevin Chen, Christine Hau, and Michael Whitney (Special Projects Committee). New officers for the 1997-1998 academic year will be elected in the fall. Professor Linn W. Hobbs and Professor Mildred S. Dresselhaus will continue as the MRS Student Chapter faculty advisors for 1997-1998. Chapter activities during the past year include: successfully creating a new and improved version of the MRS Chapter Newsletter and participating in the Symmetry Scapes '97 contest. In addition, the chapter performed a preliminary survey to check the feasibility for a Boston based New England Section of MRS, and received approval from the MRS Committee towards formal efforts to nucleate such a section. The chapter received funding from MRS to help co-sponsor the speaker series and information lunches of aMaSS; obtained travel money to help partially defray travel expenses for MIT students who attended the MRS Spring Conference; and arranged to find low cost accommodations for some incoming students who attended the MRS Fall Conference.

The Association of Materials Students Societies (aMaSS) is a coalition of student chapters of three materials professional societies: Materials Research Society (MRS), ASM International/The Materials, Metals & Minerals Society (ASM/TMS), and the American Ceramics Society (ACerS). The association was formed in 1992 with the

purpose of increasing the profile of MIT in the professional societies of materials research. Membership is offered to undergraduate and graduate students from all departments of MIT who are interested in materials. Officers of aMaSS during academic year 1996-1997 were: Andrew Gouldstone and Lori A. Maiorino (Co-Chairpersons), Valarie Benezra (Treasurer), and K. K. Greig (Secretary). The Chairpersons of the three student chapters during the academic year 1996-1997 were: T.A. Venkatesh (MRS), Laura Giovane (ASM/TMS), and Sara Ransom and Amy Hsio, (Co-Chairs, ACerS). The 1997-1998 officers of aMaSS are Melody Kuroda (Co-Chair) and Andrew Gouldstone (Speaker Chair). Elections for the remaining open officer positions of aMaSS, and for the open chair positions of the three student chapters will be held in the fall. Professor Samuel M. Allen will act as faculty advisor for aMaSS during academic year 1997-1998.

FACULTY NOTES

Faculty members of this department now occupy 14 endowed chairs. The chairholders are: Sandra L. Burkett, John Chipman Assistant Professor; Yet-Ming Chiang, Kyocera Professor of Ceramics; Thomas W. Eagar, POSCO Professor of Materials Engineering; Merton C. Flemings, Toyota Professor of Materials Processing; Lorna Gibson, Matoula S. Salapatas Professor of Materials Science and Engineering; Linn W. Hobbs, John F. Elliott Professor of Materials; Lionel C. Kimerling, Thomas Lord Professor of Materials Science and Engineering; Anne M. Mayes, Class of '48 Associate Professor of Polymer Physics; Edwin L. Thomas, Morris Cohen Professor of Materials Science and Engineering; Michael F. Rubner, TDK Professor of Materials Science and Engineering; Subra Suresh, Richard P. Simmons Professor of Metallurgy; Michael J. Cima, Sumitomo Electric Industries Professor of Engineering; John B. Vander Sande, Cecil and Ida Green Distinguished Professor; and August F. Witt, Ford Professor of Engineering.

Term chairs, especially those held by junior faculty members, are of immense value to the holders in building careers. Faculty from this department currently occupy one such chair; Caroline A. Ross, The Thomas Lord Career Development Professorship.

Visiting Associate Professor W. Craig Carter, research scientist at the National Institute of Standards and Technology in Gaithersburg, MD received the 1996-1997 Graduate Materials Committee Teaching Award. Professor Michael J. Cima was elected Fellow of the American Ceramic Society, 1997, and presented over 10 invited lectures. Professor Joel P. Clark was the keynote speaker at the VDI Conference on Life Cycle Engineering of Passenger Cars in Wolfsburg, Germany in November, 1996.

In 1996 Professor Thomas W. Eagar was the recipient for the second time since 1990 of the Warren F. Savage Award of the American Welding Society. Professor Eagar was again honored in February, 1997 when he was elected a member of the National Academy of Engineering. He was named for his contributions to the theory and practice of welding. Professor Eugene A. Fitzgerald was the Symposium Organizer for the 1996 Electronic Materials Conference, and was elected Treasurer of TMS EMPMD for a three year term, 1996-1999. Professor Merton C. Flemings chaired a NSF-sponsored Task Force charged with reviewing foundry technologies in Europe and Japan; was a Visiting Professor at the Ecole des Mines in Paris; served on the Massachusetts Governor's Council on Economic Growth and Technology; and received the Acta Metallurgica 1997 Holloman Award in Materials and Society. He has also been a leader of MIT's program with Singapore.

Professor Dorothy Hosler gave the Spring Distinguished lecture at Dumbarton Oaks Libraries and Collections (Harvard) in Washington, DC in February, 1997; was a visiting lecturer at the Colorado School of Mines during the spring of 1997; and presented The Magistral Lecture on Ancient American Metallurgy at the International Congress of Americanists in Quito, Ecuador in July, 1997. Professor Klavs Jensen was offered a visiting Hougou Professorship at the University of Wisconsin, Madison. Professor Kirk D. Kolenbrander was the first recipient of the MIT Arthur C. Smith Award for outstanding contributions to undergraduate life and learning. This annual award was established in 1997 to observe Professor Smith's departure as Dean for Undergraduate Education and Student Affairs, to commemorate his record of service in the area of undergraduate student life, and to encourage faculty participation in undergraduate student life.

Professor Ronald M. Latanision was elected to membership in the American Academy of Arts and Sciences in April, 1997, and appointed by the Massachusetts Board of Education to serve on its statewide Math and Science Education Advisory Council. Professor Robert A. Laudise was elected to the American Philosophical Society. The APS,

founded more than 250 years ago by Benjamin Franklin and friends, is the country's oldest learned society. Professor Anne M. Mayes was co-organizer of the 1996 ACS Workshop on Polymer Surfaces and Interfaces. Professor Andreas Mortensen received the Pechiney Prize, the top prize in metallurgy, which is awarded annually by the French Academy of Sciences. Dr. Robert C. O'Handley was the invited lecturer at the October, 1996 AVS Meeting.

Professor Donald R. Sadoway was named MIT MacVicar Faculty Fellow, and received the MIT School of Engineering Bose Award for Excellence in Teaching. Professor Chris E. Scott received a 1996 DuPont Young Professor Grant. Professor Subra Suresh was elected Fellow of the American Society of Mechanical Engineers. In addition, he was invited by the Austrian Academy of Sciences to visit several Austrian academic and research institutions during 1997 to deliver lectures on his research and interact with scientists whose research involves structural materials and thin films. During his sabbatical leave last year, Professor Edwin L. Thomas performed research on AFM of epitaxial films at the Institute Charles Sadron in Strasbourg, and co-authored a textbook with Professor Samuel M. Allen, as part of the Wiley-MIT Textbook Series, titled, *Structure of Materials*. Professor Carl V. Thompson was awarded a Humboldt Foundation Research Award which he will use during his sabbatical leave next year at the Max-Planck Institut für Metallforschung in Stuttgart.

Professor Harry L. Tuller was awarded a Humboldt Research Award for Senior U.S. Scientists. This award is in recognition of Professor Tuller's past achievements in research and offered him the opportunity for an extended research stay in Germany. In addition, Professor Tuller was an invited lecturer at the Technion-Israel Institute of Technology. He was invited by both the Department of Physics and Materials Engineering to present a series of seminars throughout January, 1997 covering topics on recent developments in electroceramics, as well as advances in silicon micromachining by photo-assisted electrochemical methods. Professor Tuller previously served as a postdoctoral Technion research associate prior to joining MIT in 1975.

RESEARCH HIGHLIGHTS

During the past year Professor Samuel M. Allen has completed a study that explores several strategies for toughening the TiCr₂ Laves phase intermetallic at room temperature, where Laves phases are generally brittle. In another area of his work, he has applied the Three-Dimensional Printing process to the manufacture of hardenable metal tools for injection molding of plastic parts, directly from computer-aided design (CAD) models. His approach involves three-dimensional printing of binder into tool steel powder and subsequent infiltration with molten bronze. During this year the alloy development effort for the ITER fusion experiment culminated in the fabrication of the first "full" size conductor for the TF coil in the ITER design program. The jacket material, Incoloy 908, was developed in Professor Ronald Ballinger's laboratory. Incoloy 908 is a high strength, high toughness super alloy that combines outstanding mechanical properties with physical properties, especially the thermal expansion coefficient, that match those of the superconductor, Nb₃Sn. The resulting combination allows for a savings in weight of approximately 25% for the same field strength of for a 25% increase in field strength for the same size coil.

Professor Gerbrand Ceder's research on Lithium-Metal-Oxide cathodes for rechargeable batteries has clarified the relation between chemistry, structure and intercalation voltage. This insight has led to the suggestion of a novel chemistry for this application. It appears this is one of the first materials designed by means of first-principles calculations. He is collaborating with Professor Yet-Ming Chiang to synthesize these materials. In order to facilitate first-principles predictions on complex oxides he has developed a transferable tight binding model for oxide systems. The model is almost as fast as empirical potential models, but can treat covalent and ionic systems in a coherent framework. During the past year, Professor Yet-Ming Chiang continued his research in electrically and chemically active ceramics under the support of the NSF/MRSEC program and the U.S. Department of Energy. He showed that interfaces in nanocrystalline CeO₂ have reduced oxygen defect formation energy, which explains the increased catalytic activity of the nanocrystalline form. In TiO₂ and ZnO, he showed for the first time that nanometer-thick intergranular films are an equilibrium feature of the microstructure. In processing research under Office of Naval Research sponsorship, he has demonstrated that near-electronic grade silicon carbide can be synthesized by the bulk process of reactive infiltration, yielding materials with thermal, electrical, and mechanical properties attractive for electronic packaging and structural applications.

Professor Michael Cima's most significant research accomplishments concerned application of 3DP to pharmaceutical delivery systems such as oral dosage forms. In addition, he demonstrated that a metal-organic deposition process may be an important route to high temperature superconducting coated conductors. Finally, he completed studies of the corrosion of aluminum nitride in caustic media. The later results represent the first basic studies of AlN corrosion in gold plating baths. Professor Joel P. Clark developed a research program with the University of Stuttgart, and ETH Zurich, in Life Cycle Analysis (LCA) of automotive materials and products, working with most of the automotive assemblers in the U.S. and Europe. This LCA framework is being used to analyze the costs and highlights of: new light weight designs (e.g. aluminum, steel, and polymer composite designs); electric vehicles vs. low emissions IC vehicles; and recycling technologies and policies. During the past year Professor Thomas W. Eagar's research group has shown that the fume produced when welding stainless steel has a measurable toxic effect above that produced when welding mild steel. The mild steel fume is no more toxic than other materials which are generally considered to be harmless. Thermodynamic models have shown that the chromium evaporates from the weld pool in its metallic form, and subsequently oxidizes in either the air or in water, and the form of the oxidation can be critical in the biological response. This work is particularly significant due to new proposed OSHA standards.

Professor Eugene A. Fitzgerald's work has established the microstructural origin of the current problems in the boron-diffusion process to form etch-stop layers. In other research, Professor Fitzgerald has shown that growth of graded, relaxed Si structures on off-cut wafers improves the morphology and defect structure as compared to growth on wafers without the off-cut. During the past year Professor Merton C. Flemings has qualitatively demonstrated remarkable differences between faceting and non-faceting alloys with respect to their solidification behavior in composite preforms. In another study, he finished and published work in which he demonstrated a new mechanism for phase selection in rapidly solidified alloys. One usually considers that preferential phase selection is determined by either nucleation, or growth velocity. A third possibility, however, is elimination of one phase in the early growth stages by its massive transformation to the other phase. In other research, Professor Flemings demonstrated subtle effects of structure and mold filling behavior of semi-solid alloys.

Professor Lorna J. Gibson's work sought to characterize the microstructure and mechanical properties of metallic foams for application in ultralight metal structures (e.g. sandwich panels and thin walled tubes with foam cores). In other work, Professor Gibson created a two-dimensional finite element analysis to model the relative effects on the strength of trabecular bone of thinning vs. resorption of the trabeculae. The results of this work indicated that a 10% loss of bone mass due to thinning reduces strength by roughly 20% while an equivalent loss due to resorption reduces strength by about 70%. Professor Hobbs has been active in studying the degradation of aircraft structures, as well as improving the oxidation resistance of carbon-carbon composites infiltrated with noble metals. In a new initiative on biomaterials jointly with Dr. Myron Spector, Head of Orthopaedic Research at Brigham and Women's Hospital in Boston, he has studied the nucleation and morphology of bioappetite during bone bonding at the interface between titanium implants and bone. In addition, he is working on a major program with the US Army on advanced ceramics in smart composite structures.

Professor Dorothy Hosler's work distinguishing ancient Mexican copper sources using lead isotope analyses was published in *Science*: Dorothy Hosler and Andrew Macfarlane, "Copper Sources, Metals Production, and Metals Trade;" vol. 273:1819-1824 (September, 1996). Research on pottery production in ancient Ecuador appeared in the *Journal of Material Culture* 1:1: 1996: "Technical Choices, Social Categories and Meaning among the Andean Potters of Las Animas." During his sabbatical leave Professor Jensen devoted time to developing a set of notes for subject, 10.65 "Chemical Reactor Engineering," and expanding the course to include developments in modern chemical kinetics, specifically, quantum chemistry and transition state theory. His goal is to develop a textbook for this subject.

In recent research Professor Lionel C. Kimerling studied solar cells and wafer engineering transition metal gettering from the bulk by an Al eutectic liquid, and by heavy boron doping. In other areas of research he has studied environmentally benign semiconductor manufacturing and demonstrated an in-line monitor for chemical recycling, and developed a prototype with Millipore Corporation. Professor Kirk D. Kolenbrander's research demonstrated the effect of particle size and quantum confinement on the luminescence properties of nanoscale silicon thin films. He further showed that the intensity of visible photoluminescence from those films is dependent upon the degree of surface passivation on the nanoparticles, while the emission energy is independent of the specific chemical nature of

the passivating species. These results are all consistent with a simple quantum confinement model of emission where particle size determines emission energy and surface passivation determines emission intensity.

Professor Ronald M. Latanision's research involved the development of supercritical water as a vehicle for chemical waste destruction. The selection of the materials of construction for large scale systems is the central focus of his work. In particular, he has identified thermodynamic conditions in potential-pH-temperature space which allow materials such as nickel-based and titanium-based alloys to be protected while not compromising the waste destruction efficiency. Professor Heather N. Lechtman's research revolved about the three-month summer archaeological/geological field investigation she carried out in Bolivia and Chile. The purpose was to assemble a representative suite of arsenical copper ore and nickel ores from N. Bolivia and Chile and lead isotope analysis. The field sampling survey was prompted by her discovery in 1995 of production of ternary Cu-As-Ni alloy by ancient metalworkers in Bolivia and Chile during Middle Horizon (ca A.D. 600-100). The ore sources utilized for this alloy and the smelting procedures involved in its preparation are part of a much broader study of ancient bronze (Cu-As, Cu-As-Ni, Cu-Sn) in the Andean world. Professor Anne M. Mayes initiated a program to develop a new solid state rechargeable lithium battery working in collaboration with Professors Ceder, Chiang, and Sadoway. The material is easily processed into thin films, allowing greater freedom in battery configuration.

Professor Frederick J. McGarry's work showed that chemical crosslinking of UHMWPE reduces wear in simulated hip joint to zero, and has applied for a patent on this work. In other work, he has produced stronger, tougher fiberglass/silicone resin laminates when resin is toughened with PDMS rubber. Two patent applications have been filed on this work to date. Dr. O'Handley's pioneering work of imaging and explaining the domain structure in ultrathin Cu/Ni/Cu/Si (001) films received wide acclaim. His work has spawned newly funded programs in novel actuator materials (Finland), and stress effects in magnetic thin film devices. Professor Uday B. Pal patented an environmentally sound and efficient process for refining molten metals by utilizing solid-state electrochemical cells. Pilot trials on refining copper are being conducted at Reading Tube Corporation in Pennsylvania. He also patented an improved steelmaking process which utilizes electronic pathways to enhance electrochemical smelting reactions. Research on industrial implementation is in progress with government and industrial support from Fluoro-Daniels. In addition, he developed the theory to design efficient multi-layer electrochemical devices. These are being synthesized for applications in fuel cells, metal extraction, and solid-state sensors.

Professor David M. Paul co-authored a paper with H. Neal Bertram of the University of California, San Diego titled, "Magnetization Distribution in Thin Films with Perpendicular Surface Anisotropy" which was accepted for publication in the *Journal of Applied Physics*, 1997. It represents the first time the dynamics of the magnetization process in very thin films has been satisfactorily explained. In the past year Professor Robert M. Rose analyzed the radiation physics of sterilization as it is used for orthopaedic implants made of ultrahigh molecular weight polyethylene. Markedly nonuniform distributions of free radicals are predicted, which implies corresponding nonuniformities in sterilization and aging. Professor David K. Roylance's research has centered on the durability of filled elastomers subjected to large cyclic loads, the role of chain extension versus crosslinking in high-temperature polymer matrix resins, the role of processing variables on the morphology and properties of toughened polyamide resins, the modeling of flow and heat transfer during infiltration processing of composites, and the response of ultraoriented fibers to high-speed impact. Professor Kenneth C. Russell further developed his theory for unusual nucleation processes which occur in such non-equilibrium materials as thin films undergoing ion mixing and light water reactor pressure vessels undergoing irradiation.

Professor Donald R. Sadoway studied the generation of the perfluorocarbons (PFCs), CF₄ and C₂F₆ in a laboratory-scale aluminum reduction cell. He found a strong correlation between PFC concentration in the off gas and the overvoltage on the anode. On the basis of the theory of electrode kinetics he derived the functional relationship between the rate of PFC generation and anodic overvoltage. Professor Chris E. Scott has implemented numerical simulation of breakup and coalescence of droplets using the 2D immiscible lattice-fluid model. The data indicated a transition from stable drops which do not break to drops which do break near a critical capillary number of approximately one. In addition, his understanding of the phase inversion mechanism during compounding of immiscible polymer blends has advanced rapidly. Contrary to the current conceptual model for the phase inversion mechanism, he has clearly proved that the relative transition temperatures are not the only factors that control which polymer initially becomes the continuous phase during dissipative mix-melting. Professor Subra Suresh filed for two U.S. patents. The first is for a new device and methodology for microindentation testing and measurement of

mechanical properties on a microscopic scale, and negotiations are underway for the commercialization of this work through Instron Corporation. The second is on a procedure and apparatus for measuring processing-induced internal stresses in layered and graded coatings.

Professor Edwin L. Thomas published an article in *Science* concerning the first reports of a novel smectic O type phase in a rod-coil block copolymer. He investigated the physics of self assembly of liquid crystalline rod block-noncrystalline flexible coil block copolymers for a series of block copolymers and compared the results with recent theoretical work. Over the past year Professor Carl V. Thompson has developed and used a microstructure-sensitive simulation of electromigration and electromigration-induced failure in interconnects in integrated circuits. He has extended his experiments and modeling of structure and texture evolution in polycrystalline films to include concomitant stress evolution. Professor Harry Tuller has continued his work on developing compatible electrode/solid electrolyte systems for high temperature fuel cells, and investigating electrical activity at grain boundaries in semiconducting oxides. The new *Journal of Electroceramics* with Professor Tuller as Editor-in-Chief was launched with the first issue published in April, 1997. He has begun collaborative work with colleagues at the Max Planck Institute of Solid State Research in Stuttgart, Germany.

Professor John B. Vander Sande continued his work on thermomagnetic processing of superconducting. Part of this research involved processing $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_x$ as thick films on Ag substrates at elevated temperatures and fields. World class superconducting properties were achieved for this system through this process. In other work, he has investigated two aspects of soot formation from combustion processes. In one study, he has attempted to develop "soot prints" in order to assign soot to a particular source. In a different study, he has produced an impressively diverse morphology of fullerene macromolecules by burning flames. Professor August F. Witt's research work continued on a concept for steady state crystal growth and segregation in a Bridgman configuration. Professor Bernhard J. Wuensch performed neutron and x-ray scattering to establish the state of disorder in several fast-ion conducting pyrochlore systems and has used the structural results to interpret the variation of ionic conductivity with composition of the solid solutions. The dermal regeneration template discovered by Professor Ioannis Yannas (referred to commonly as 'artificial skin') was approved by the FDA in 1996. This analog of the extracellular matrix is a molecular scaffold which induces regeneration of dermis over indefinitely large areas in the patient's body and, in doing so, inhibits scar formation.

DEPARTMENTAL AWARDS

A. N. Sreeram, who finished his ScD at MIT a year and a half ago with Professor Linn W. Hobbs, was presented with the "DSRC Outstanding Technical Achievement Award" at the annual award presentation ceremony held in September, 1996. This is the second highest Sarnoff recognition award (the highest being the Sarnoff 'lifetime' achievement award, which is given to one person every year).

The initiates during the 1996-1997 academic year into the MA Beta Chapter of Tau Beta Pi Engineering Honor Society were: Melody M. Kuroda, Wendy L. Mao, Amy C. Richards, Justin L. Sanchez, and Patrick E. Trapa.

The initiate during the 1996-1997 academic year into the Xi Chapter of Phi Beta Kappa was Neil T. Jenkins of Nashport, Ohio, in recognition of his scholarly attainment in the liberal arts and sciences.

In May, 1997 six seniors were accepted as associate members in the Society of Sigma Xi, The Scientific Research Society of North America: Martin Gilkes, Neil T. Jenkins, Anand Raghunathan, Amy Richards, Matthew Van Eman, and Lorraine Wang.

Senior Douglas W. Howie won the award for best DMSE undergraduate thesis in June, 1997 for his thesis, "The Effect of Processing on the Performance of Ruthenium Chelate: Polyethylene Glycol Blend Based Electroluminescent Devices," which was written under the supervision of Professor Michael F. Rubner. Lisa Kinder was elected Recording Secretary at the American Ceramic Society/National Institute of Ceramic Engineers (ACeRs/NICE) Student Congress, which was held in Cocoa Beach, Florida from January 10-14, 1997. Other DMSE students attending the congress were junior Kim-Marie Levis and graduate student Andy Kim of Professor Eugene A. Fitzgerald's group.

Melody Kuroda, a DMSE junior from Waipahu, Hawaii, received several prestigious awards during academic year 1996-1997. They were: the 1996 Myrtle and Earl Walker Scholarship awarded by the Society of Manufacturing Engineers; the 1996 George A. Roberts Scholarship awarded by the ASM Foundation for Education and Research; the 1996 Claiborne and Nuala Pell Scholarship awarded by the Coalition of Higher Education Assistance Organizations (COHEAO); and the 1997 TMS/Structural Materials Division awarded by The Metals, Minerals, and Materials Society (TMS). In addition, she was selected as a recipient of a Barry M. Goldwater Scholarship awarded by the Barry M. Goldwater Foundation. The competition for these scholarships was intense, with the Goldwater Foundation receiving more than 1,164 nominations from which only 282 award recipients were chosen.

Senior Matthew R. Vaneman was among 80 college undergraduates chosen for the 1996 Summer Medical and Research Training Program at Baylor College of Medicine in Houston, TX. The 10-week program, for which more than 700 applied, is designed for students interested in careers in scientific research and offers first-hand work experience in laboratories conducting biomedical projects. One of the sponsors is the National Heart, Lung and Blood Institute of the National Institutes of Health.

Four seniors who graduated in June, 1997 received National Science Foundation (NSF) Graduate Fellowships: Jiang-Ti Kong, Sara Ransom, Amy Richards, and Lorraine Wang. Ben Hellweg and Neil Jenkins were also selected for NSF Fellowships, but chose to accept Department of Defense (DOD) Fellowships. All of these students will be pursuing their graduate studies at MIT during the 1997-1998 academic year, except Lorraine Wang, who will attend Stanford in the fall.

In May, 1997 ten graduate students were accepted as associate members of the Society of Sigma Xi: Vanessa Chan, Matthew Currie, Jason Heine, Anil Jain, Alice Man, Patricio Mendez, Ramabhadra Ratnagiri, Pradeep Skreekanthan, Srikar Vengallatore, and Vicky Yong. Eight graduate students were accepted as full members of the Society of Sigma Xi: Jeffrey Bour, Valarie Benezra, Douglas Blom, Brian Galley, Rizwan Gal, Honglin Guo, Sridhar Seetharaman, and Eric Werwa.

Valarie Benezra received the 1997 Henry Broomfield Rogers Fellowship, Geetha Berera was awarded the 1997 Mary Ingram Bunting Sciences Fellowship. This fellowship is awarded to women graduate students by the Dean of the Graduate School. Kevin W. Eberman was the recipient of a grant from the U.S. National Committee for Crystallography to permit travel to present a paper at XVII Congress and General Assembly of the International Union of Crystallography, Seattle, WA. Anne-Valerie Ruzett was awarded a Belgian American Foundation Fellowship for the 1997-1998 school year.

Srikanth Samavedam received an award for Best Student Presentation for the work he presented at the 1996 TMS/IEEE Electronic Materials Conference in Santa Barbara, CA titled, "Improvement in Surface Morphology and Dislocation Structure in Graded SiGe/Si Structures Grown on Off-cut Substrates." He received free support for attending this year's conference, a \$500 award, and a plaque. Matt Silva was awarded a New Investigator Award by the Orthopaedic Research Society for his abstract titled, "Computed tomography based finite element analysis predicts failure loads and fracture patterns for vertebral sections," presented at the 1996 Annual Meeting. The John Wulff Award for Excellence in Teaching during academic year 1996-1997 was awarded to three teaching assistants: Jason A. Gratt, Sridhar Seetharaman and Eric Werwa.

Fellowship awards for one or more semesters were held during academic year 1996-1997 by 48 students: Stephen C. Britten, NDSEG Fellowship; Tracey A. Burr, NDSEG Fellowship; Kevin M. Chen, NDSEG/SCEEE Fellowship; Matthew J. Farinelli, NDSEG/SCEEE Fellowship; Michael E. Groenert, NDSEG/SCEEE Fellowship; Jason R. Heine, NDSEG/SCEEE Fellowship; Olivera E. Kesler, NDSEG Fellowship; Andrew Y. Kim, NDSEG/SCEEE Fellowship; Samuel A. Newell, NDSEG/SCEEE Fellowship and MIT Environment Fellowship; James E. Neely III, DOE Fellowship; Aimee L. Smith, DOE Fellowship; Anton F. Van der Ven, DOE Fellowship; Laura M. Giovane, DOD Fellowship; Erika D. Abbas, ONR/SCEEE Fellowship; Kevin W. Eberman, ONR/SCEEE Fellowship; Jason A. Gratt, ONR/SCEEE Fellowship; Adam C. Powell IV, AT&T CRFP Fellowship; Eric Werwa, AT&T CRFP Fellowship; Alice M. Man, EPA Fellowship, Aimee L. Smith, Ida M. Green Fellowship; Jeffrey D. Nystrom, Kurtz Fellowship; Paul R. Birch, NSF Fellowship; Christine S. Hau, NSF Fellowship; Brian D. Judd, NSF Fellowship; Thomas A. Langdo, NSF Fellowship; Debra J. Lightly, NSF Fellowship; Michael J. Fasolka, NSF Fellowship; Darrell J. Irvine, NSF Fellowship; Erin B. Lavik, NSF Fellowship; Randy Logan, NSF Fellowship; Sanjeev Makan,

NSF Fellowship; Martin L. Panchula, NSF Fellowship; Vanessa Z.-H. Chan, NSF Fellowship; Benita J. Dair, NSF Fellowship; Michael F. Durstock, NSF Fellowship; Randolph E. Kirchain, Jr., NSF Fellowship; Andrew Gouldstone, Butzow Fellowship; Mauro Kobrinsky, Rocca Fellowship; Francis Johnson, STARR Fellowship; Kevin K.D. Lee, STARR Fellowship; Christopher J. Vineis, STARR Fellowship; Matthew T. Currie, Loeb Foundation Fellowship; Min-ha Hwang, Loeb Foundation Fellowship; Douglas J. Twisselmann, Loeb Foundation Fellowship; Chinedum Osuji, PPST Fellowship; Elicia M. Maine, International Motor Vehicle Program and Canadian Research Council Fellowship; Anna M. Lokka, International Motor Vehicle Program Fellowship and TEKES Fellowship (Finland); Thomas Besson, MPMI Fellowship.

CLOSING REMARKS

From the foregoing it is clear that the Department of Materials Science and Engineering remains quite active—in education, in research, and in professional recognition—both within MIT and externally. It is the activity of the faculty and students which helps us maintain our preeminent ranking among other materials departments in the United States. Nonetheless, there are a number of challenges which confront us if we are to maintain these standards of excellence. Specifically, we have a number of new faculty positions open which we must fill during the next several years. This alone will place a severe financial strain on the department. In addition, it is essential that we begin to renovate all of Building 8 which has generally not been improved since the 1930's. This is particularly critical if we are to move forcefully into the area of biomaterials research. Fortunately, our alumni and friends have been very generous over the last few years, and with their continued support we believe that we will be able to accomplish many of these objectives.

More information about this department can be found on the World Wide Web at the following URL: <http://www-dmse.mit.edu/>

Thomas W. Eagar

DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering has achieved a great deal in Academic Year 1996-97. Course II and Course II-A's new undergraduate curricula are making the intended impact on the quality of our undergraduate education. Faculty members are devoting a significant part of their effort to make the new curriculum successful.

The Department's new research effort in the field of information science and technology is progressing well. This is, in part, due to the strong faculty team active in the information area, some of whom have joined the Department recently. Similar efforts are being made in the fields of energy and bioengineering to strengthen the research infrastructure, consolidate existing activities, promote synergistic activities, and increase the external visibility in the fields of energy and bioengineering. Our newly established Center for Innovation in Product Development funded by NSF is expected to make a significant and positive impact on the Department's research and education. These activities are complementing other strong research efforts in manufacturing systems and engineering science areas.

The student enrollment in the Department has been nearly constant over the past decade with approximately 14% of all MIT sophomores, juniors and seniors and 382 graduate students.

The high cost of implementing the new curricula and enhanced educational activities that require more extensive laboratory support has placed a large strain on our budget. The Department also has a critical shortage of space which is impacting the quality of our educational and research programs. These are not new problems, but now we have reached a point where we are seriously compromising the essence of intellectual strengths of the Department of Mechanical Engineering.

The Department of Mechanical Engineering continues to enjoy the highest reputation among all mechanical engineering departments in the United States. To maintain this tradition, we continuously re-examine all aspects of our educational and research activities.

Our departmental goals of the last five years have been as follows:

Education: To create future leaders in engineering, industry, research, academia, and society at large.

Our specific goals are: (1) to provide a broad-based engineering education, (2) to develop an ability to execute engineering tasks by providing students with an integrated view of engineering, (3) to encourage active learning, (4) to provide hands-on experience, and (5) to enhance the students' ability to deal with engineering tasks using both analytical and design skills.

Our graduate program is designed to provide professional and scholarly education for those interested in academic, industrial and research careers. We continue to emphasize original research as an integral part of graduate education.

Research: The Department is seeking to make impact on society, industry, academia, and the knowledge base by being the best at the two opposing ends of the research spectrum, i.e., fundamental knowledge generation and technological innovation.

Service: The Department is keenly aware of the fact that for MIT to succeed, we must work with other universities to improve the quality of education; and with industry, to help them become competitive and productive. Ultimately, we seek to improve the quality of life for humankind.

We revised the undergraduate curricula for Course II and for Course II-A to help us achieve these goals in all three areas. Course II-A is intended for those who seek education at the interface between traditional mechanical engineering and other disciplines such as biology, business, public policy, large systems, and information.

The Department formed large research groups in order to increase flexibility and intellectual opportunities. In addition to those in design, manufacturing, and information, we are in the final stages of forming large research groups in bioengineering and thermal energy. These research groups draw their intellectual base from the basic disciplines that are present within the Department as well from those outside.

Research programs of the Department are strong. The MIT-Industry Partnership for Engineering Excellence was formed to strengthen our research support base and to conduct long term research efforts in areas of industrial importance. Efforts are also being made to conduct large systems research programs to teach students all aspects of systems engineering by involving them in this type of research. The Department's faculty has taken a leadership role in creating an NSF funded Engineering Research Center. It was a highly competitive grant to obtain, in part because MIT already has an ERC in bio-processing. Many of the new faculty members have quickly established strong research programs with significant funding. We expect the Department research volume to increase substantially during the next academic year.

An ongoing effort is being made to solicit gifts from our alumni, friends and corporations to continue to strengthen the financial base of the Department. We need more senior chairs for faculty, better space for research and education, more fellowships for graduate students, and a funding base to initiate new research endeavors in areas that have not yet been explored.

UNDERGRADUATE CURRICULUM

Our new undergraduate curriculum in Course II has made a major impact for the betterment of the learning process for our students. An example is the new required subject 2.670 (Mechanical Engineering Tools). This two-week, 80 hour subject offered during IAP has changed the outlook of our undergraduate students. They learn the essence of engineering in this subject through acquiring computer and machining skills. This course also promotes a close fellowship among 150 sophomores at a scale never achieved before. Professors Douglas Hart and Kevin Otto received the Joseph Keenan Award for Innovation in Teaching for their initiative and effort in developing this subject.

The goals of our educational programs were previously stated in the introductory section. It is worth, however, repeating our ultimate goal: to produce future leaders for society, industry, academia, and in fact, in all walks of life. We think our students have all the ingredients necessary to become leaders and our intellectually gifted faculty can provide the mentorship they need. The Undergraduate Curriculum Committee has done an outstanding job of implementing the new curriculum under the leadership of Professor John Heywood who will pass this tradition to the new committee chairman, Professor David Gossard.

One of the major intellectual challenges of the new curriculum is that we have begun to work on the integration of subjects in the four required sequences:

- Sequence 1: Mechanics and Materials
- Sequence 2: Systems, Dynamics, and Control
- Sequence 3: Thermodynamics, Heat transfer, and Fluids
- Sequence 4: Design and Manufacturing

These efforts will be coordinated by "Designated Professors" who will be in charge of these subjects. They will determine, with the help of other colleagues, the course content, develop teaching materials, and establish faculty consensus. These professors will be at the center stage of the curriculum improvement.

We still face several challenges. The foremost is the need for continuing financial support to sustain our current activities to develop new teaching materials. One of the central concepts of the new curriculum requires a completely new set of teaching materials because we want to provide students with an integrated view of engineering by teaching, for example, thermodynamics, heat transfer, and fluid mechanics in an integrated manner. This process began concurrently with the new curriculum. We must maintain the current momentum to get the job done over the next three years. Considering the extreme importance of this effort, we should not be doing it at the margin due to the lack of funds.

The Department believes that in the long run, one of the key ingredients to improving education is the use of technology. We feel that technology enhances the learning process. Technology can play an important role in providing distance learning to our alumni and others. The Department created the Hypermedia Teaching Facility to begin the arduous task of developing teaching materials using hypermedia and web based technology. We made

much progress, but decided to form a joint venture with the Center for Advanced Educational Services (CAES) due to cost considerations as well as for the overall improvement in its operation. The Department will continue to participate in the Hypermedia Teaching Facility, but the primary operational responsibility has been turned over to CAES.

The Department has revised the curriculum for Course II-A. The goal of Course II-A is to provide a more flexible curriculum for those interested in seeking a broader education than the more structured Course II. The six options currently provided under Course II-A are:

1. Biomedical Engineering and Pre-Medicine
2. Technology-Policy and Pre-Law
3. Management and Entrepreneurship
4. Large-Scale Systems Design
5. Information and Computation
6. Open Track

Our goal is to increase the enrollment of students in Course II-A substantially. Professor Seth Lloyd, the professor in charge of Course II-A, has initiated a number of activities to introduce the freshmen class to Course II-A. The goal is to have a total of about 150 students in II-A when it reaches a steady state operation.

RESEARCH

One of the ultimate goals of the Department is to redefine the discipline of mechanical engineering in the area of research. Historically, mechanical engineering owes its origin to machinery, automobiles, and other mechanical equipment, which utilize force, energy, and motion. Through these devices, information, energy, motion, and force were both stored and transmitted. Over the last three decades, however, a significant fraction of information in these devices has been replaced by digital devices. Mechanical motion has been controlled by computers which provide intelligence. Micro-electrico-mechanical sensors have also expanded the intelligence of mechanical systems. New materials and new manufacturing techniques are changing the nature of mechanical products. These expanded capabilities are increasing the application areas in which mechanical engineers can play pivotal roles. Furthermore, future mechanical engineers must acquire a new set of knowledge to be able to deal with engineering systems that are not purely mechanical.

The Department conducts research in the following areas:

- Research Group 1: Manufacturing Systems and Technology
- Research Group 2: Design and Product Development
- Research Group 3: Bioengineering and biomedical engineering
- Research Group 4: Information Systems and Technology
- Research Group 5: Energy systems and technology

These groups draw their intellectual strengths from all parts of MIT. Within the Department, the faculty members who are in the following three disciplinary divisions contribute to the Research Groups: Mechanics and Materials, Thermal and Fluid Sciences, and Design and Systems Divisions.

Research Groups 3 and 5 are being formed through active discussion among the faculty. The goal is to undertake large systems research projects, provide a better environment for research and education (especially for non-tenured faculty members), and establish new intellectual frontiers which can make important contributions to the knowledge base and technology innovation. One of the ideas actively being pursued is the creation of large laboratory units for greater collaboration, visibility, synergism, and more effective research fund raising. It has been the experience of the Department that junior faculty members associated with large laboratories such as the Laboratory for Manufacturing and Productivity and the d'Arbeloff Laboratory for Information Systems and Technology have a better success rate in establishing their research activities. The intellectual infrastructure provided by these large laboratories must account for this difference.

The Department is also interested in reinforcing the engineering science base of the mechanical engineering disciplines. A strategic plan is being formulated to identify important intellectual issues that need to be addressed in the future. One of the changes we need to implement as soon as possible is the re-establishment of specialized graduate subjects with small enrollments because it is known that these specialized subjects make our Department and MIT, more attractive to potential graduate students. At this time graduate subjects with less than 10 students are offered only in alternate years due to fiscal constraints.

CHALLENGES

There are many short- and long-term challenges facing the Department. The foremost on the short-term list is the lack of space for the Manufacturing Institute and the Center for Innovation in Product Development. We need to have this issue resolved in the near future at the School and on the Institute level. Another space related issue is the renovation of Buildings 3 and 35 laboratories.

Another short-term challenge is the need to continue funding for curriculum development. We need to invest about \$250,000 a year for three additional years. We will be seeking both external and internal support for this activity.

The Department has also initiated the MIT-Industry Partnership for Engineering Excellence with Silicon Valley Group, Inc. as its first partner. The goal of the program is to establish a long-term relationship with industrial firms so that MIT can conduct fundamental research in the partner firms' areas of interest. Both MIT and partner companies gain in achieving their mutual and individual goals. We are trying to expand this program.

We have initiated an important activity to strengthen and broaden our graduate educational program. Under the leadership of Professor Ali Argon, a faculty committee reviewed the current graduate program and made recommendations to introduce new graduate educational programs for those students whose interests lie in industrial careers. As a result of this effort, the Department is considering the following options, which require the approval of the faculty:

EXPANDING GRADUATE EDUCATION AT THE MASTER'S DEGREE LEVEL

Create Master of Engineering (M.Eng.) Degree Programs for specific areas such as manufacturing, design, computation, etc.). These one-year programs will be offered to those students who have three to five year industrial experience and will require an industrially based project in place of a thesis and eight subjects -- 6 H level and 2 G level subjects.

The goal of the SDM Program is consistent with the Department's desire to educate people who can deal with engineering systems issues. Therefore, the Department is planning to participate in this program more aggressively, especially through the Center for Innovation in Product Development and the Manufacturing Institute.

GRADUATE EDUCATION AT THE DOCTORATE LEVEL

As mentioned previously, the Argon Committee recommended that the Department consider creating a doctoral level degree program that can meet the needs of students interested in industrial careers. Among the rationale for such a program are:

- The traditional Ph.D. Program does not meet the needs of domestic students interested in industrial careers. This is suggested by the fact that while only about 25% of incoming graduate students are foreign students, 75% of Ph.D. students are foreign students. This has both positive and negative implications.
- Doctoral level graduate education will understandably improve the quality of engineering practice in industry.
- The professional growth of some of the Ph.D.s in industry is limited by their lack of breadth and image.

The details of the curriculum for this type of doctoral program need to be developed. Many ideas, however, are being considered such as a thesis done in industry, systems related research, two major areas of study, etc.

MAJOR ACCOMPLISHMENTS AND SPECIAL EVENTS

One of the major accomplishments and events of the Department in AY 1996-97 was the dedication of the newly established d'Arbeloff Laboratory for Information Systems and Technology, which is the home for information-based research and teaching activities of the Department. The goal was to create a new educational and research

paradigm in areas where sensor technology, software, communications technology, and traditional mechanical engineering disciplines merge. We assembled a strong faculty group in this laboratory representing a diverse set of disciplinary backgrounds. The faculty members include Professors Harry Asada (Director), Ian Hunter (Co-Director), Steve Dubowsky, Derek Rowell, Jean-Jacques Slotine, Seth Lloyd, and Sunny Siu. They have many active research projects, the largest being the Home Automation and Health Care Consortium.

Another dedication marked the growing support for the Department's efforts to provide training and use of current and future computational tools for undergraduate students of Mechanical Engineering. The Papken Der Torossian Undergraduate Computing Facility also serves as the electronic classroom for many Department courses as well as training in specialized software unique to mechanical engineering.

SPECIAL RECOGNITION

The faculty members continue to receive major recognition. Over the Academic Year 1996-97, the following faculty members were recognized for their various contributions:

Professor H. Harry Asada named Ford Professor of Mechanical Engineering.

Professor Warren Seering named Weber- Shaughness Professor.

Professor Neville Hogan received an Honorary Doctorate from Delft University.

Professor Peter Griffith received the J.P. Den Hartog Distinguished Educator Award.

Professor Kai-Yeung Siu received the 1997 IEEE Browder J. Thompson Memorial Prize Award for the best paper for all of their publications written by someone under the age of 30.

Professor Alex Slocum received the SME's Frederick W. Taylor Award. He also received four IR 100 Awards.

Dr. Stanley Gershwin was elected a Fellow of IEEE.

Professor Mary Boyce received the Ruth and Joel Spira Teaching Award.

Professor Anthony Patera was named the School of Engineering Professor of Innovation.

Dr. Henry Paynter, Emeritus, was elected to the National Academy of Engineering .

Professor Nam P. Suh was awarded the 1997 Ho-Am Prize for Engineering.

Professor Rohan Abeyaratne was elected Fellow, American Academy of Mechanics.

Professor Ian Hunter was elected to Newsweek's Century Club which named the "100 people to watch as America prepares to pass through the gate to the next millennium".

Professor Alan J Grodzinsky and his student, Mike Buschmann, won the Melville Medal for the best original paper across the entire ASME.

Professor Anna C. Thornton was named the Class of 1943 Career Development Professor.

The Department continues to attract some of the most promising young faculty members. The following faculty members joined the Department in Academic Year 1996-97: Peter So, Assistant Professor, Interest in biomedical engineering, and Lakshminarayanan (Maha) Mahadevan, Assistant Professor, Interest in mechanics and materials.

Professor Peter Griffith retired on June 30, 1997.

Nam P. Suh

DEPARTMENT OF NUCLEAR ENGINEERING

The Department of Nuclear Engineering (NED), the youngest department of engineering at the Institute, has completed its 39th year of existence. The year witnessed the inauguration of the first career development chair dedicated to nuclear engineering and the inauguration of a new endowed fellowship.

The department was again rated the top department in its field by *US News and World Report*. The consistency of this ranking over many years has reflected the quality of scholarship by students and faculty in the department.

This year was marked with extensive activities involving lectures and seminars, drawing on speakers from outside the Institute as well as from the department and its associated interdepartmental laboratories: the Plasma Science and Fusion Center, the Nuclear Reactor Laboratory, the Francis Bitter Magnet Laboratory, and the Energy Laboratory.

Albert Carnesale, Provost of Harvard University and Professor of Public Policy and Administration, was the invited speaker at the David J. Rose Lecture in Nuclear Technology, held on October 7, 1996. Professor Carnesale spoke to an enthusiastic gathering on the topic of Nuclear Proliferation After the Cold War.

On April 7, 1997, the department offered a day-long symposium entitled Advances in Nuclear Technology. This event gave students and visitors an opportunity to learn more about current research within the department. Presentations included Nuclear Medical Technology, Industrial Applications of Nuclear Sciences, Nuclear Energy in the 21st Century, and Nuclear Systems Reliability and Management.

In conjunction with this event, a special celebration/reception was held to mark the endowment of the Norman C. Rasmussen Career Development Chair in Nuclear Engineering. This chair honors Professor Emeritus Norman C. Rasmussen, department head from 1975 to 1981, who retired in 1994 after 36 years on the faculty. Professor Rasmussen, well known for his work in the area of nuclear risk assessment, directed the 1974 Reactor Safety Study, which was sponsored by the US Nuclear Regulatory Commission.

Assistant Professor Kenneth R. Czerwinski became the first holder of the Rasmussen chair. Professor Czerwinski, who joined the department in November 1996, is an expert in radiochemistry of heavy elements such as the actinides. His research interests cover environmental and waste technology aspects of nuclear materials.

Professor Ronald Latanision, professor of materials science and engineering since 1974, began a joint professorship with NED and the Department of Materials Science and Engineering. His research interests include materials processing and the corrosion of metals and other materials in aqueous environments.

On June 12, the first annual Virtual Information in Education Conference was hosted by Professor Kevin Wenzel in collaboration with National Instruments. This conference provided educators who use virtual instrumentation an opportunity to discuss new and innovative approaches to teaching engineering, physical science, and life sciences.

A new endowed fellowship in nuclear engineering, the William T. and Ann D. McCormick Fellowship, was initiated this year, the first beneficiary being Kory Sylvester, a Ph.D. student in the area of energy and policy.

UNDERGRADUATE PROGRAM

Seventeen students were enrolled in the undergraduate program during the past year (seven sophomores, five juniors, four seniors, and one fifth-year). Two students completed requirements for the bachelor's degree in nuclear engineering.

Department faculty offered six freshman advisory seminars in fall 1996.

The spring 1996 term project of subject 22.033/33 Nuclear Systems Design Project received a second place award in the design contest of the Education and Training Division of the American Nuclear Society.

GRADUATE PROGRAM

Thirty-nine students entered the graduate program in September, bringing the total graduate enrollment to 121 students. Forty-five percent are specializing in fission and energy studies, 36 percent are working in radiation applications in biomedical and other technology, and 19 percent in fusion. A total of 33 degrees were awarded to 31 students during the academic year. The first Master of Engineering in nuclear engineering was awarded to Frederick Nielsen at the June commencement.

Three of the four subjects developed as part of the Core Curriculum were offered during the current academic year. The fourth subject will be introduced in fall 1997. This subject, 22.104 Nuclear Reactor Laboratory, replaces two lab offerings, 22.59 and 22.69.

A new doctoral qualifying exam structure was developed to concentrate more heavily on core elements in the first phase and allow flexible schedule of the specialty testing as a second phase. It will be implemented in fall 1997.

Graduate subject 22.811 Sustainable Energy was reorganized, and a new course, 22.351 Current Nuclear Fuel Cycle Issues, was offered during the academic year.

A graduate program brochure was revised during the current academic year. Its purpose is to highlight departmental research, and it is used to enhance our recruiting efforts. It is also accessible through the NED Web page.

FACULTY HONORS, AWARDS, AND ACTIVITIES

The Ruth and Joel Spira Award for Distinguished Teaching was presented to Professor Richard Lester. This award acknowledges the tradition of high quality engineering education at MIT. Through the Industrial Performance Center, Professor Lester and coworkers released a major study of the future of economic development in Hong Kong.

The American Nuclear Society (ANS) MIT Student Chapter Outstanding Teaching Award was presented to Professor Neil Todreas.

At the ANS Annual Meeting in Orlando, Professor Jacquelyn Yanch received the ANS Young Member Engineering Achievement Award for 1997.

Professor Emeritus Gordon Brownell was made an Honorary Fellow of the American College of Nuclear Medicine. This award recognizes significant contributions to the field of nuclear medicine.

Professor Sidney Yip was the lead organizer of a workshop on quantitative methods in materials research at the Institute for Theoretical Physics, University of California Santa Barbara. This six-month program was funded by the National Science Foundation.

Professor Sow-Hsin Chen and a former student, Michael Kotlarchyk, developed a textbook on *Interaction of Photons and Neutrons with Matter*. The book is designed to teach non-relativistic quantum electrodynamics to engineering students who are preparing to do research in materials characterization using radiation.

Professor Ian Hutchinson served on the editorial board of the journal *Plasma Physics and Controlled Fusion*, and was appointed series editor of the "Cambridge Monographs on Plasma Physics" published by Cambridge University Press. He was an invited speaker at the 23rd European Physical Society Conference on Controlled Fusion and Plasma Physics, held in Kiev, Ukraine.

Professor David Cory was invited to speak at several conferences. These included Keystone Conference on Magnetic Resonance, Keystone, CO, August 1996; and Major Analytical Instrument Facility 25th Anniversary Symposium Series, Cleveland, Ohio, October 1996. During April 1997, he was an invited speaker at the American Chemical Society Conference, the Golden Gate Polymer Forum, and the IBM Almaden Research Lab.

Professor Todreas chaired the Fifth International Conference on Thermalhydraulics and Operation of Power Reactors, held in China in April 1997. Professor Kazimi co-chaired the best paper award at this meeting.

Professor George Apostolakis chaired the American Nuclear Society International Topical Meeting on Probabilistic Safety Assessment: Moving Toward Risk-Based Regulation, held in Park City, Utah, October 1996.

RESEARCH

FISSION

Professors Neil Todreas, Michael Driscoll, and Michael Golay continued investigating the feasibility and economic factors involved in extending power reactor operating cycle lengths as a strategy to achieve higher capacity factors. Professors Todreas and Driscoll continued their design of a thermosyphon loop for passive cooling of advanced double concrete wall containment buildings. A scaled test loop is also being constructed to determine the performance of the loop's inner evaporator, the component that limits loop performance due to the presence of noncondensable gas with the steam within the containment.

Professors Mujid Kazimi and Michael Driscoll have initiated an investigation of the economics and environmental aspects of fuel cycles that reduce the amount of spent fuel and high level waste per unit energy produced. This includes the reuse of spent nuclear fuel from light water reactors into heavy water reactors.

Professor John Meyer has been examining modification of light water reactors to obtain extended cycle durations. His contributions involve the core thermal hydraulics and fuel rod lifetime concerns.

Professor Apostolakis continues to work on software dependability assessment using formal methods and the dynamic flowgraph methodology. Regarding aging effects in probabilistic safety assessment, models are being developed for flow-accelerated corrosion. Accident sequence precursor methodology for fire precursors has been completed. The methodology behind environmental decision-making involving multiple stakeholders has been tested and is now complete. Organizational factors affecting on-line maintenance have been investigated.

During the year, Professor Ronald Ballinger made a significant advance in the effort to understand and to predict the environmental degradation in Pressurized Water Reactor (PWR) steam generator tubing with the generation of the first crack initiation and growth data using actual steam generator tubing in prototypic environments with in-service loads. The data are now being used to improve predictive models.

RADIATION SCIENCE AND TECHNOLOGY

Professor Yip's research in atomistic simulation of materials properties and behavior expanded considerably to include three new funded projects: thermomechanical performance of fiber-matrix composites, nonlinear fluid flows in microchannels, and plastic deformation in bcc transition metals. The last effort is a collaboration with Dr. Vasily Bulatov of Mechanical Engineering and Professor Tomas Arias of Physics.

Professor Chen's research efforts succeeded in using small-angle neutron scattering technique to measure interfacial curvatures in bicontinuous phase separated fluids and porous materials. The curvatures are the most significant quantities which characterize the mesoscopic-scale morphology of such two-phase systems. This technique was applied for the first time to show how the average Gaussian curvature of a microemulsion changes when such a self organized liquid undergoes a bicontinuous to globular structural transition.

Professor Lawrence Lidsky and his group have continued their work on the electron-beam production of Molybdenum-99, a key isotope for medical diagnostics. New experiments have shown that the same equipment may also be used for the production of other isotopes not easily made by current techniques.

Professor Yanch and her group in the Laboratory for Accelerator Beam Applications (LABA) were successful in generating almost one milliamper of proton current using the tandem electrostatic accelerator at LABA. This represents the highest current achieved with any accelerator of this type in this energy range. Particle beams were then used to generate neutrons using three different charged particle reactions. The clinical feasibility of this approach to producing neutron beams for BNCT is under investigation at LABA.

A major accomplishment in Professor Yanch's group was the demonstration that practical accelerator targets can be made for BNCT from the point of view of heat removal. The problem of target cooling has long been referred to as

the stumbling block for accelerator-based BNCT. Professor Yanch, students, and industrial colleagues from Newton Scientific, Incorporated, demonstrated that power levels in excess of 5 kW/cm could be safely handled using the cooling method of submerged jet impingement. Also under investigation at LABA is the application of BNCT to the treatment of rheumatoid arthritis, an approach that Professor Yanch has termed Boron Neutron Capture Synovectomy. Major accomplishments over the past year include verification of boron uptake in arthritic rabbits. Results show that sufficient compound is taken up by the diseased tissue to permit therapeutic treatment to be carried out in less than 20 minutes. Determination of treatment efficacy is underway.

Professor Cory's research in High Resolution NMR Microscopy continues to push for high resolution and sensitivity NMR microscopic images, particularly through the implementation of diffusion insensitive slice selection methods, rapid constant time imaging schemes based on reduced k-space sampling and the characterization of micron structures via local gradients. Recently he explored the applications of RF gradients to bi-linear rotation sequences (BIRD and TANGO) and developed a more robust two channel NMR probe. Regarding High Resolution NMR Scattering research, the spin diffusion measurements discussed above, and an improved version of the high gradient strength probe have been completed. Professor Cory and his researchers are now turning their attention to measures of local morphology in semi-crystalline solids.

In collaboration with Professor P. Culligan-Hensley, Civil and Environmental Engineering, Professor Cory is working on MRI of Soil Remediation. They completed a set of measurements that show the images of oil displacement by a water stream in a packed bead system. This provides the only direct, non-invasive three-dimensional data on the efficiency and is needed as a link to microscopic models of the system.

In the area of NMR Applications to Liposarcoma Grading, Professor Cory and Dr. S. Singer, BWI and Dana Farber, have seen that gradient HR-MAS is indeed a powerful means of exploring the chemistry and compartmentalization of sarcomas and have expanded the study to include cultured cell lines.

Professor Xiao-Lin Zhou is working on two projects. The first is neutron reflectometry and applications in the area of Neutron Scattering Spectroscopy; the second is Near-Threshold Reactions for Neutron Production in the Area of Compact Neutron Sources. In the first project, the engineering design of a white-beam neutron reflectometer for surface and thin film research has been completed, and 70 percent of the instrument construction has been implemented. Along with Professor P.S. Pershan of Harvard, they have advanced a Groove-tracking method (GTM) for reflectivity data analysis by developing a smoothed GTM method. They have also developed and demonstrated a mirror-reflection method for neutron spectrum measurement. In the epithermal neutron production project, they have completed a thorough analysis of near-threshold p-Li reaction and established the feasibility of near-threshold production of epithermal neutrons.

FUSION

The Alcator C-Mod tokamak, under the leadership of Professor Hutchinson, is one of two major US tokamak facilities and is recognized as one of the five key divertor tokamaks in the world. Alcator C-Mod is the only diverted high-field compact experiment in operation and, therefore, it plays a unique role in providing critical tests of confinement scaling and theory at high power density. Because of its high power density, C-Mod contributes uniquely to ways of achieving ignition at low cost, and of exploring advanced tokamak physics regimes. Its vertical plate divertor geometry has been adopted as the reference design for the International Thermonuclear Experimental Reactor (ITER). It was found that the plasma naturally enters an operational regime called Enhanced D-alpha, in which the energy confinement is high but the edge particle confinement is modest. This is ideal for a reactor or next-step experiments in which one wishes to keep the energy in but allow impurities or helium ash to escape. Detailed physics studies to identify the processes involved in this phenomenon are just beginning.

Professor Jeffrey Freidberg has proposed a simple model to explain the empirical energy confinement time observed in Reversed Field Pinch (RFP) experiments. As opposed to carrying out detailed micro-turbulence calculations, he and his students have suggested that the plasma profiles relax to a state of marginal stability against ideal MHD modes, specifically the Suydam criterion. The analysis predicts precisely the same scaling with plasma parameters and geometry as the empirical relation with a very similar numerical coefficient.

Professor Freidberg and his associates continue their research on several projects in the area of Magnet Science and Technology. Regarding Ramp Rate Limitation in Superconducting Magnets, a theory has been derived which describes a robust mechanism for the observed ramp rate limitation in high field superconducting magnets. It compares reasonably well with experimental data and explains why such magnets quench significantly below their predicted DC current limit during rapid ramping of the current.

Regarding AC Losses in Superconducting Cables, a continuum theory has been formulated and analyzed with the goal of calculating AC losses in multi-strand superconducting cables used for fusion magnets, a critical problem during current ramping. Criteria are derived which show how to minimize these losses. Regarding Multi-Channel Flow in Superconducting Cables, a theory has been derived to describe the thermal hydraulic behavior of superconducting magnets with a central cooling channel. It is shown that two channel (or multi-channel) systems can be reduced to an equivalent single fluid model whose properties include anomalously large (i.e., a factor of 100) thermal and particle diffusion coefficients. The predictions of the theory are in excellent agreement with experiment.

Regarding Magnetic Field Mapping, a novel procedure has been suggested for mapping the magnetic fields in large detectors used in high energy physics detectors. The method is fast, accurate, and economical with respect to existing techniques. It makes use of analogous surface mapping procedures used widely in the magnetic fusion community. The procedure is currently being implemented on the PHENIX detector at Brookhaven Laboratory.

Design and construction of a new test facility for high heat fluxes has been undertaken by Professors Kazimi and Meyer. Tests using the facility will cover the design parameters best suited to extract high heat fluxes with very cold water flowing at high. This is particularly important for plasma facing components such as the divertor.

During the year, Professor Ballinger's alloy development effort for the ITER fusion experiment culminated in the fabrication of the first "full" size conductor for the TF coil in the ITER design program. The jacket material, Incoloy 908, was developed at MIT in Professor Ballinger's laboratory. Incoloy 908 is a high strength, high toughness super alloy that combines outstanding mechanical properties with physical properties, especially the thermal expansion coefficient, that match those of the superconductor, Nb3Sn. The resulting combination allows for a savings in weight of approximately 25 percent for the same field strength or a 25 percent increase in field strength for the same size coil. These savings translate directly to a comparable savings in cost.

ENVIRONMENT AND WASTE TECHNOLOGY AND POLICY

Professor Czerwinski's primary focus is trivalent actinides in real systems. His work involves modeling a waste site at ORNL and calculating the amount of Am and Cm bound to fulvic acids in the groundwater.

Professor Kazimi and his students have formulated a multiattribute utility model for decision analysis in the cleanup of the nuclear waste tanks at Hanford. The model allows for the uncertainties in the technical, environmental, and economic factors in evaluating alternatives for the cleanup process. Also, it allows for the summation of the attributes with weighting functions that are to be specified by the user. In their recent work the group suggested the concept of least variance in the multiattribute utility as an optimization parameter for the utility function.

Application of the model to deciding on the amount of water to be extracted for remediation versus the amount that can be treated in-place reveals that the in-place burial offers better options if the current interagency agreement were to be modified to allow such options. From a cost perspective, the options with minimum waste disposal outside the site are found to be the most desirable, but also the most uncertain. From a multiattribute point of view, the advanced separations of radioactive elements are found to provide the highest multiattribute values.

Professor Ballinger has made significant advances in the understanding of the environmental degradation of aluminum alloys used for aircraft. Corrosion related damage is the primary source of airframe degradation. The understanding of aircraft aging is critical to the development of strategies for the extension of the useful life for current and planned airframes. Several (actually most) airframes now in service are over 20 years old—in the case of the B-52, more than 30 years old. As part of the University Research Initiative (URI), funded by the AFOSR, a quantitative relationship between the role of rivet/structure interaction and degradation has been established. This understanding has led to the development of criteria for new rivet material for use in replacement and future applications.

Professors Kent Hansen and Michael Golay continued work on models of the management and operation of the cleanup process for the Hanford Waste Tank Farm.

STUDENT AWARDS AND ACTIVITIES

The MIT American Nuclear Society Student Branch is the organizational center for extracurricular NED student functions. There have been many social and athletic events during the year, reflecting the interests of its members. The Monday Afternoon Seminar Series, NED Orientation for incoming students, holiday party, and international dinner are just 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 nine outstanding students for their academic achievement. The MIT Health Physics Society Student Branch's activities are focused on environmental radiation transport, radiobiology, and radiation detection and measurement.

Several students were recognized at the annual international dinner/awards ceremony. The Roy Axford award for outstanding academic achievement by a senior in nuclear engineering was given to Jerry Hughes, Jr., and Melissa Lambeth. The Irving Kaplan award, which recognizes academic achievement by a junior in nuclear engineering, was presented to Eric Empey.

The Manson Benedict Fellowship for 1997-98 will be shared by Khashayar Shadman (fall term) and Eugene Bae (spring term) in recognition of their excellence in academic performance and professional promise. The Theos Thompson Memorial Fellowship was held by Mark Skubis during spring 1997.

As mentioned earlier, the McCormick Fellowship was offered in the spring of 1997 for the first holder: Kory Budlong Sylvester. The Sherman Knapp Scholarship, funded by Northeast Utilities, was presented to Vicentica Valdes. National Academy for Nuclear Training Fellowships for 1996-97 were held by David Gierga (health physics), Susan White, John Goorley, and Jeffrey Dulik (nuclear engineering).

The Outstanding Student Service Award, which recognizes exceptional services to the students, the department, and the entire MIT community, was presented to Christopher Handwerk. The Outstanding TA Award was initiated to recognize exceptional services to education by a teaching assistant. Wen-Yih (Isaac) Tseng was chosen for this honor.

Upon the recommendation of the department, the Dean of the Graduate Education Office selected Yun Long, an incoming graduate student, for the Chyn Duog Shiah Memorial Fellowship.

Eric Empey received the 1997 ANS Undergraduate Scholarship Award for a student entering the field of nuclear science and engineering. This award was officially presented to him at the awards luncheon during the June ANS Annual Meeting in Orlando, Florida.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/ned/www/>.

Mujid S. Kazimi

DEPARTMENT OF OCEAN ENGINEERING

Academic year 1996-97 was an event filled year for the Department of Ocean Engineering. While our faculty continued with their long range plan of strengthening our undergraduate program, we were also successful in raising funds to endow an Education Laboratory to help with this effort. The laboratory setup is now complete and operational under the supervision of Professor Chryssostomos Chryssostomidis and Dr. Thomas Consi.

Our strong and vital graduate program continues to attract some of the best students from the United States and around the world. Work on our new graduate curriculum was started in 1995 and we expect it to be in place by September 1998. We also continue with our effort to strengthen our relationship with Woods Hole Oceanographic Institution. As a result of this effort, our Master of Engineering degree is now part of the joint MIT-Woods Hole Program, combining the best the two institutions have to offer.

Our present faculty continues to engage in research that enjoys national and international recognition. The new Fabrication Laboratory is being developed to assist the Department in its effort to help the U.S. modernize the shipbuilding industry. Professor Masubuchi was instrumental in securing the donation of a state-of-the-art welding robot and its power supply. The welding robot is a key instrument for the new laboratory which is under the supervision of Professor Nicholas M. Patrikalakis.

In this past year six of our senior faculty retired. Two of these, Professors Kerwin and Masubuchi, returned with 49% appointments. One new assistant professor was appointed. This brought our faculty strength to thirteen full-time plus the two at 49% effort. In addition, we have our two U.S. Navy Professors. A search has been completed to recruit an additional faculty member, who will come on board July 1, 1997.

UNDERGRADUATE EDUCATION

The Department's undergraduate curriculum focuses on five areas: Hydrodynamics and Oceanography; Structures and Materials; Dynamics and Wave Propagation; Mathematics and Computation; and Design/Application/Experience.

During our retreat in December 1996, the Department concluded that its undergraduate curriculum continues to provide a solid foundation in all the basics that make the discipline of Ocean Engineering. As a result, no changes of substance were proposed. The Department reaffirmed its resolve to continue with its investment in the undergraduate program by continuing with our cooperative program with industry, expanding our association with sea going organizations such as the *Sea Association*, and strengthening our public image. However, as part of our strategy to increase our undergraduate enrollment, we will continue to review our undergraduate program on an annual basis to ensure that it is up to date and fine tune it as necessary. One such example of this fine tuning is the introduction of a common project in the following subjects: 13.016 "Introduction to Geometric Modeling and Computation" (a subject in our Mathematics and Computation area), and 13.017 "Design of Ocean Systems I" (a subject in our Design/Applications/Experience area).

Such coordination between subjects increases the efficiency of our teaching enterprise and provides the students with more comprehensive education.

Our undergraduate enrollment has gradually, but steadily increased from seven in FY93 to fourteen in FY97. Part of our long term strategy is to continue to add to our experimental facilities used in our undergraduate educational program. In 1996 a new testing tank was constructed and used in the instruction of our undergraduate design subject. The new tank is specially equipped with laser-induced visualization capability, which is being used by students in the design and development of small autonomous underwater vehicles. This past spring we set up a new Education Laboratory (Chryssostomidis/Consi) for hands on capabilities by our undergraduate students. This is being funded in part by one of our alumni, Mr. Hin Chew Chung. The only stipulation made by the donor was that the funds be used for education and preferably to provide space where students will be allowed to work together. This laboratory will be used during the academic year to teach our Design subjects 13.017 and 13.018, "Design of Ocean Systems I and II". This way the students will have the space and equipment necessary to work on their designs. We also intend to provide mini-subjects of laboratory techniques needed in modern Ocean Engineering such as marine electronics, bioacoustics and flow visualization. Future plans include development of new curricula to address new and evolving

areas in ocean engineering such as biomimicis and new techniques of delivering engineering education. Although the principal focus of the laboratory is Ocean Engineering, some of its products are likely to have wider application.

Dr. Thomas R. Consi, a new addition to the Department, has been brought in specifically to help us develop the Ocean Engineering Education Laboratory. While Professor Chryssostomidis remains the laboratory director, Dr. Consi will handle the day to day operation of the laboratory as the laboratory manager. He has considerable experience advising undergraduates and coordinating undergraduate research. The laboratory is currently operating and has several undergraduates working on projects.

Our Acoustics and Vibration Laboratory (Baggeroer, Schmidt, and Vandiver) and the Crashworthiness Laboratory (Wierzbicki) are currently operating as research facilities, however, they were designed in such a manner as to allow them to be used by our undergraduate as well as graduate program. An Instron machine has recently been relocated to this space and will also be available to our undergraduates to perform basic strength of materials experiments.

The Department, in collaboration with the MIT Sea Grant College Program, continues to be very active in the Undergraduate Research Opportunities Program (UROP). During FY97 we had nine UROP students for Fall '96, fifteen for Spring '97, and eleven for the Summer '97. Out of this total of thirty-five students, twelve are from course 13. The Department funded from its General funds (budgeted for UROP), six of these students. The remainder of the students were covered by departmental and Sea Grant research accounts and funds from the UROP Office.

The Department feels that the UROP program is an excellent educational vehicle and we continue to increase our support in this area to allow more undergraduate students to become exposed to the research conducted in our Department. It is our intention to continue this UROP program and make it an integral part of the Education Laboratory.

GRADUATE EDUCATION

Our major educational project the last two years has been the revision of our graduate curriculum done in collaboration with our colleagues from Woods Hole Oceanographic Institution (WHOI). During our retreat in December, 1996, (as well as during our retreat in January 1996), the results of this major undertaking were extensively discussed.

The new acoustic curriculum redirects the teaching emphasis towards environmental disciplines. The principal focus of the new curriculum is on understanding the ocean acoustic environment, development of man-made systems with less environmental impact and the use of acoustics for measuring environmental properties. Three existing subjects were eliminated and two new subjects were introduced. This consolidation allows the Department to maintain its national leadership in marine acoustics with our current faculty reduction from four to three.

The pedagogical objective of the Ocean Engineering graduate Design and Marine Robotics curriculum is to make students proficient in the entire range of conceptual, preliminary, and detailed design and the production of ocean vehicles. This curriculum supports the Naval Construction and Engineering Course 13A, the M.S. Degrees in Naval Architecture and Ocean Engineering and the Naval or Ocean Engineer degrees. It also provides the synthesis component required for breadth in our doctoral programs.

We also offer an advanced subject in Computational Geometry in collaboration with Civil and Environmental Engineering and Mechanical Engineering, thus supporting the Institute in the Computer Aided Design and Manufacturing areas. A new subject in Robotics and Sensor Fusion is currently under consideration. Such a subject would benefit Courses 2 and 6 as well.

The objective of our Hydrodynamics curriculum is to educate students in the fundamentals and applications of hydrodynamics as it impacts the areas of naval architecture and ocean engineering. We once again continue to build upon the strengths of our existing curriculum, thus streamlining our existing subjects and introducing a new theoretical subject addressing viscous and turbulent marine flows. The new hydrodynamics curriculum is composed of one introductory and three basic subjects to introduce our students to the fundamentals of marine hydrodynamics as well as a number of application subjects which will expose our students to the latest developments in

hydrodynamic research. Our current curriculum does not cover the experimental hydrodynamics subject to the depth we prefer as we do not have the personnel to develop the necessary research and educational components of a coherent program in this area.

The educational objective of the Management of Marine Systems is to prepare naval architects, marine engineers, and ocean engineers to apply their engineering knowledge in the "real world." To do so, they must understand the social and institutional infrastructure in which they will be working and integrate their engineering knowledge into the management, economics, policy and law aspects of the world around them. Presently the current focus is on shipping and coastal management.

The graduate program in Structures and Structural Engineering gives a student a broad understanding of the behavior of structural components and systems and the material from which they are made. We collaborate with the Departments of Mechanical Engineering and Materials Science and Engineering to provide a well rounded curriculum. Our Departmental subjects emphasize those aspects unique to Ocean Engineering. The curriculum in Structures and Structural Dynamics covers all the important needs of the Department, but our manpower is such that it does not allow for any expansion into new areas.

Our current status in graduate curriculum development builds upon the previous curriculum, which placed Ocean Engineering in the forefront of marine education. We continuously monitor our curriculum and our faculty is committed to evaluating all the changes and taking action where necessary.

In addition to the above changes in our curriculum which we expect to be totally integrated into our program by September 98, we also made our Master of Engineering part of the joint MIT-WHOI program. In this manner we now offer a unique educational program that combines the best the two institutions have to offer.

RESEARCH

The department's faculty and staff continued in their pursuit of a variety of outstanding research programs. Many of these are currently receiving worldwide attention both inside and outside the field of ocean engineering.

Professor Koichi Masubuchi has recently received funding for further advancement of welding technology from multiple sponsors . This program covers three areas including underwater welding, use of computers in welding, and analysis of reliability of welded structures.

Professor Tomasz Wierzbicki is continuing with Phase II of his Grounding Protection of Oil Tankers. The objective of the project is to upgrade and validate the computer program DAMAGE for grounding analysis of oil tankers and to include in the analysis damage to side, bilge, bow and stern. In addition, an extensive study on strength, ductility and fracture of welds with defects, will be undertaken.

Professor Michael Triantafyllou is working on a three and a half year project to explore the parameters leading to drag reduction and turbulence suppression in fish-like propulsion and to develop flow-sensing apparatus to perform closed-loop studies. In addition, he is also working with Draper Laboratory on a project to optimize the fast-starting maneuver of flexible hull vehicles using an existing robotic mechanism in the OE Testing Tank facility. Professor Triantafyllou also continues to work on his "Robotuna" and his "Robopike", an autonomous fish-like vehicle funded by Sea Grant.

In order to sustain our leadership role, the Department maintains a number of state-of-the-art laboratories. A complete listing of the research laboratories maintained by the Department is given below:

LABORATORY

Acoustic & Vibration Laboratory(5-007)
Design Laboratory(5-423)
Fabrication Laboratory(5-034)
Impact & Crashworthiness Laboratory(5-007)
Laboratory for Ship and Platform Flows(5-329B)
Marine Hydrodynamics Laboratory(3-269)
Testing Tank(48-015)
Vortical Flow Research Laboratory(5-303)
Education Laboratory(5-028)
Marine Robotics Laboratory(5-025)
Marine Computation & Instrumentation Laboratory(1-225)

SUPERVISOR

Professor Henrik Schmidt and J. Kim Vandiver
Professor Chrys Chryssostomidis
Professor Nicholas Patrikalakis
Professor Tomasz Wierzbicki
Professor Paul Sclavounos
Professor Justin Kerwin
Professor Michael Triantafyllou
Professor Dick Yue
Professor Chrys Chryssotomidis, Dr. Thomas Consi
Professor John Leonard
Professor Jerome Milgram

The Fabrication Laboratory is a new facility dedicated to research in fabrication techniques of large complex systems. This new laboratory occupies the space formerly occupied by Professor Masubuchi's Welding Laboratory. Professor Masubuchi was instrumental in securing a state-of-the-art welding robot and its power supply from Kawasaki Heavy Industries and Daihen Corporation, respectively. The robot and the power supply donation was made during the major symposium sponsored by Ocean Engineering to celebrate Professor Masubuchi's lifetime achievements and are key instruments for the research of the new laboratory. A dedication ceremony with a brief demonstration was recently held with members of Kawasaki Heavy Industries present, as well as Professor Nicholas M. Patrikalakis, the new Kawasaki Professorship recipient.

The Department continues to enjoy a close relationship with the Autonomous Underwater Vehicle Laboratory at Sea Grant and with a number of laboratories at WHOI.

DEPARTMENTAL AWARDS AND ACTIVITIES

Captain Alan J. Brown, USN continued as Professor and Head of the Naval Construction and Engineering Program with LCDR Mark S. Welsh, USN continuing as Associate Professor of Naval Construction and Engineering.

Dr. William Carey served as a Senior Lecturer in the Department teaching graduate courses in Shallow Water acoustics and sonar technology. He is working with ARPA and MIT to develop a comprehensive report on Shallow Water Sonar Technology which addresses the key performance and system technology issues concerning active/passive system performance in key littoral regions.

Professors Carmichael, Dyer, Newman and Ogilvie retired but continued with student supervision and some teaching and research.

Professor Chryssostomos Chryssostomidis played a key role in obtaining a grant from Hin Chew Chung to set up an endowed account for support of the Education Laboratory in the Department.

Professor Ernst G. Frankel continues with his lecture series in the Center for Advanced Engineering Studies (CAES).

Professors Kerwin and Masubuchi retired but returned with 49% appointments and are active in teaching, student supervision and research.

Professor Justin E. Kerwin was invited to be the Nineteenth Weinblum Memorial Lecturer. This lecture was given in Hamburg, Germany in January 1997 (to coincide with the Weinblum centennial), and in Washington, D.C. in April 1997.

Professor Judith T. Kildow continued working on her book *Environmental Management of the Coast*, a textbook for her course 13.98J. A copy has been submitted to the publisher and is currently being edited for publication.

Professor John J. Leonard was appointed Assistant Professor effective July 1, 1996. He was awarded the Henry L. and Grace Doherty Professorship in Ocean Utilization from 1997-1999.

Professor Henry S. Marcus continues to hold the NAVSEA Chair (through ONR).

Professor Koichi Masubuchi was instrumental in obtaining a grant from the Katayanagi Institute (KI) and setting up the Koh Katayanagi Fund in the Department. Funds from this endowed account will be used to strengthen research and teaching and enhance cooperation between KI and MIT.

Professor Jerome H. Milgram was on sabbatical performing research at WHOI and Johns Hopkins University. At WHOI he worked on the combination of hydrodynamics and control of underwater vehicles. At Johns Hopkins University he has been working on the computer-based signal processing of 3-D Particle Image Velocity Holograms.

Professor T. Francis Ogilvie received an honorary doctorate in naval architecture and marine engineering from National Technical University of Athens in October 1996.

Professor Nicholas M. Patrikalakis received the Kawasaki Professorship effective October 1996.

Professor Henrik Schmidt was an invited presenter on "Real Time Oceanography" to the Marine Board, National Research Council, June 1996. Professor Schmidt also stepped down as CGSP representative effective June 30, 1997.

Professor Paul D. Sclavounos was appointed to the Det Norske Veritas North American Committee Advising DnV Board.

Professor Michael S. Triantafyllou was elected Associate Editor of *The Journal of Fluids Engineering* (ASME) for three years, 1996-1999.

Professor J. Kim Vandiver became the new CGSP representative effective July 1, 1997. In addition Professor Vandiver continues to serve as Director of the Edgerton Center which provides opportunities for students, especially freshmen, to engage in projects in engineering and science.

Professor Tomasz Wierzbicki was invited to give a series of lectures at the NATO Summer School in Portugal in July 1996 on "Crashworthiness of Transportation Systems - Structural Impact and Occupant Protection."

Professor Dick K.-P. Yue was on sabbatical for FY97 at Stanford University in the Environmental Fluid Mechanics Lab and Center for Turbulence Research. His focus was on particle velocimetry, similar to what is currently being done in the MIT Testing Tank.

Neil Best, a graduate student in Ocean Engineering, received a Sea Grant Industrial Fellowship for FY97.

Justin Manley, also a graduate student in the Department, was the recipient of the Society of Naval Architects and Marine Engineers (SNAME) and the American Society of Naval Engineers (ASNE) scholarship awards for FY98.

Mr. J. Paul Marquardt, an undergraduate, was the recipient of the SNAME Undergraduate Scholarship Award for FY97. William R. Kreamer has been nominated for the FY98 award.

The winner of the 1997 Wallace Prize, Ms. Taryn N. Westberg, will be provided a full year of tuition and stipend. Taryn was selected from a list of extremely qualified candidates.

Morten W. Hoegh, a senior in the Department, was presented with a tuition award for academic achievement during his junior year.

Dr. Thomas Consi was awarded the Martin A. Abkowitz International Fellowship which he will use toward covering expenses during his attendance at the 4th European Conference on Artificial Life (ECAL97) which will be held in Brighton, England July 97.

In addition, Professor Michael Triantafyllou was also awarded funding which he will use towards providing travel expense funds for students to attend the American Physical Society in San Francisco.

The Fourteenth Wallace Lecture was presented in November 1996 by Dr. James G. Bellingham of the MIT Sea Grant College Program. The title of the lecture was "Observing the Ocean."

The second lecture held in October of 1996 was given by Dr. David Newman on "Simulations of Flow over a Flexible Cable". Dr. Newman is currently a postdoctoral scholar in Caltech's Aeronautics division working in the Solid Mechanics group on parallel 3-D adaptive meshing problems.

This event is part of a series of symposia and workshops established in 1986 to bring together Navy, Industry and Academia to discuss important educational and research issues that affect naval construction and engineering and to help expose our Naval officer-students in Course XIII-A to the communities with which they will have to interact after graduation.

The most recent event was held on May 21-22, 1997. Invited guests included members of the naval-ship design community, U.S. Laboratories and the Office of Naval Research, as well as several major shipbuilders for the U.S. Navy. The featured speaker was the Honorable John Douglass.

ALUMNI EVENTS

Our 17th annual reunion was held at the New York Marriott Marquis on October 3, 1996. Professor Chryssostomidis gave a brief presentation to the alumni and brought them up to date with regard to the department and its activities.

More information about the Department of Ocean Engineering can be found on the World Wide Web at the following URL: <http://web.mit.edu/ocean/www>.

Chryssostomos Chryssostomidis

ARTIFICIAL INTELLIGENCE LABORATORY

The Artificial Intelligence Laboratory has as its scientific mission the goal of answering the question: How does the human mind work? There are many corollary questions to answer: Where does the mind reside? What is the nature of memory? What are the roles of emotions? What sort of representations does the brain use? What does our visual system compute? How did evolution shape us? How do we learn? What is consciousness?

Today we have the first opportunity in twenty years to attack all these questions in decisive new ways. New tools, new resources and new information are all available. If we can think imaginatively enough and turn that imagination into solid scientific theories and solid engineering demonstrations then we can meet this grand challenge.

WHY NOW?

A number of events are converging that make this time one of great promise for our research:

- There has been a realization amongst many people at our Lab that the keys to intelligence are self adapting perceptual systems, motor systems, and language related modules. This is in marked contrast to earlier approaches that focused on reasoning, planning, and knowledge representations as the keys to Artificial Intelligence.
- A whole host of new techniques for imaging the brain while it perceives, acts, and produces utterances are giving new insights into how components of human intelligence interact. The answers all look very different from earlier models derived from introspection and protocol analysis. Multi-cell recording in animal nervous systems is further illuminating how natural systems perceive, remember, and act.
- From 1970 to 1990 the peak amount of computer power available for an individual AI researcher (anywhere) remained approximately constant at around 1 mps, while the cost dropped a factor of 200, as we (generic computer researchers) migrated from one big computer for a whole lab to individual workstations. Since 1990 we have picked up more than two orders of magnitude processing for individual graduate students with approximately constant cost. In addition much larger central computational systems are becoming available for dedicated experiments, giving yet another order of magnitude increase. This trend will continue as costs remain constant.

We are thus armed with a new direction, we have new data on how natural systems work, and we have significant new levels of computation available.

Our challenge is to take these three components that have been thrust upon us (to a greater or lesser degree by developments over the last thirty years made within the Lab itself, mixed with many outside developments) and synthesize new scientific results, create new engineering applications, and to answer the big question.

WHAT HAPPENS ALONG THE WAY?

Since Marvin Minsky and John McCarthy formed the Lab in 1959 it has always been a place where significant new tools and applications have been developed.

The great strength of the AI Lab has always been a willingness to put together large scale systems in ways that others have either not dared or for which they have not been able to marshal the required resources. Since the very early days the Lab has also been a place where robotics and computer vision have been great strengths. In all areas we have had much success in the building of software and computer hardware systems.

These traditions are all alive and well, and the last few years have seen significant applications built on our robotics, vision, language, and circuit design technology. We have recently pioneered new methods for image guided surgery, wired the Whitehouse, made haptic interfaces a reality, produced new generations of micro displays, and changed the way NASA explores planets. Twenty active companies have spun off from the Lab in just the last few years.

This activity will not abate any time soon. There are dozens of new applications currently being developed at the Lab helping surgeons, assisting the disabled, replacing precision mechanical components with computation, building

new classes of human computer interfaces, providing new capabilities in image indexing, and hijacking biochemistry to do computation for us.

Our work in exploring intelligence feeds these applications. Our work on applications gives us new tools to explore intelligence. It is a symbiosis that has worked for us for a long time, and it appears that it will continue to work for the foreseeable future.

RECENT PROGRESS

The last year has seen a number of our areas of our research come to fruition.

- Essentially all the ideas in the Deep Blue chess program that beat Kasparov this year were present in the MacHack chess program developed by Richard Greenblatt at the AI Lab in 1965, and subsequently put into the Chess Machine by in the mid seventies. Deep Blue was just a much faster version of these earlier systems, and Greenblatt was honored along with the Deep Blue team at the American Association for Artificial Intelligence annual meeting this year.
- The image guided surgery system pioneered by Professor Grimson of our laboratory was transitioned from an MIT graduate student operated experimental system to a functional hospital operated system for regularly scheduled brain surgery at Brigham and Women's Hospital and is now in daily use.
- The Mars rover Sojourner which is a direct descendant from robots built by Colin Angle while a UROP and graduate student at the AI Lab and on summer assignment at JPL proved the operational worth of the behavior-based approach to robotics first introduced by the AI Lab in 1985 and steadily developed here over the following decade.

More information about the Artificial Intelligence Lab can be found on the World Wide Web at the following URL:
<http://www.ai.mit.edu>

Rodney A. Brooks

BIOTECHNOLOGY PROCESS ENGINEERING CENTER

The Biotechnology Process Engineering Center (BPEC), an interdepartmental center at the Massachusetts Institute of Technology, established in May 1985, is funded by the National Science Foundation (NSF) under the Engineering Research Center Initiative. Through the BPEC's multidisciplinary body of faculty members, the center executes its educational, research and industrial functions to ensure the competitiveness of the US biotechnology industry. The vision and goals of this Center is to act as pioneers and leaders to the academic, industrial and government communities; to perform cutting-edge and generic research; to foster interdisciplinary educational activities; and to initiate relationships with industry, involving both collaboration and technology transfer.

INFRASTRUCTURE

As an interdepartmental center, the BPEC reports to the Dean of Engineering, Robert A. Brown. The two research thrust areas each have Thrust Area Leaders. In Thrust Area I: Therapeutic Protein and Nucleic Acid Production, the Thrust Area Leaders are Professor Gregory N. Stephanopoulos (Chemical Engineering), Professor Anthony J. Sinskey (Biology), and Professor Martin L. Yarmush (Mass General Hospital). The leaders in Thrust Area II: Protein and Nucleic Acid Aggregation, Stability, Formulation and Delivery, are Professor Alexander M. Klibanov (Chemistry) and Professor Jonathan A. King (Biology). The Thrust Areas meet once a month for half a day to discuss the research and future programs. An Industrial Advisory Board assists the center in its overall management. Since the Board members are also part of the center's Industrial Consortium, they attend the center's biannual consortium meetings. At these meetings, the Board members meet in a separate executive session with the center's Director and the Thrust Area Leaders. Input from the Board members is provided by the members both orally and in a written report submitted to the center's Director.

The BPEC faculty execute the strategic planning of the center's research and other activities. These meetings are generally divided into the two research thrusts with certain faculty members overlapping in both thrusts. During fiscal 1997, six strategic planning meetings were held in order to plan the center's long-range research activities. The Associate Director of the center is Professor Gregory N. Stephanopoulos. The major role played by the Associate Director is the planning and execution of the research, as well as acting as the primary faculty interface with the Industrial Consortium. To assist the Associate Director with the industrial programs is Dr. James C. Leung, the Industrial Coordinator.

Ms. Audrey Jones Childs is the Assistant Director for Administration and Operations. The Assistant Director handles the center's human resource, purchasing, prepares and monitors all budgets and proposals, and prepares statistical reports. In addition, the Assistant Director is the direct liaison with the School of Engineering. Both the Director and Assistant Director are liaisons with the National Science Foundation ERC Division. Three part-time administrative staff workers in addition to the Education Coordinator assist Ms. Childs. One additional faculty member was added to the center during fiscal 1997, Professor Douglas A. Lauffenburger. This addition was made due to Professor Lauffenburger's research interests which are directly related to the center's present activities as well as the future initiatives in nucleic acid biotechnology.

RESEARCH STRUCTURE

A cross-disciplinary team consisting of biologists, chemists, and chemical engineers executes the research in two thrust areas: 1. Therapeutic Protein Production: Quantity and Quality, and 2. Therapeutic Protein Aggregation, Stability, Formulation and Delivery. Cross-disciplinary educational and research collaborations are especially important components of the center's activities.

A team of 15 faculty members participated in the center's activities from July 1, 1996 through June 30, 1997. They are from the Departments of Chemical Engineering (School of Engineering), Biology, Brain and Cognitive Science, and Chemistry (School of Science), the Mass. General Hospital/MIT's Harvard Science and Technology Program, Department of Chemistry at Iowa State University, and the Department of Chemistry at Purdue University. Undergraduate and graduate students, postdoctoral fellows, visiting scientists, and industrial associates are also integral participants in the center's activities. Statistically reporting, 254 personnel took part in the center's research

activities during fiscal 1997. This figure comprises of the following: 83 MIT Undergraduate Research Opportunities Program students (UROP), four MIT Undergraduates working on course-related thesis projects; 16 non MIT undergraduates from 14 different Universities who participated in the center's NSF Research Education for Undergraduates Program (REU); 63 graduate students from four departments; 51 postdoctoral associates/fellows; 33 visiting scientists, engineers, industry researchers, four other administrative personnel and 15 faculty. The NSF provides the major financial support for BPEC personnel. The National Institutes of Health (NIH-NIGMS) provides additional support for graduate educational activities for the MIT students. The NSF (34%), industry (24%), and other sources (42%) support the center's research and administration.

AFFIRMATIVE ACTION

The BPEC is committed to increasing the number of women and minorities in its programs. Our success is dependent on the type of applicants. To strengthen the number of applicants for the National Institutes of Health Interdepartmental Training Grant, we reformed our minority recruitment committee this past year to analyze and address the current recruitment procedures. Ms. Araba Lamousé-Smith has been appointed chairperson of this committee. The following two specific examples highlight BPEC's recruitment activities. First, Ms. Araba Lamousé-Smith again recruited undergraduates at the National Society of Black Engineering National Conference. Second, Mr. John Galvin researched contacts at additional minority universities, colleges and programs for the REU solicitation. Our recruiting effort was quite successful, having under-represented populations in the BPEC in the following numbers; American Indian—3, Pacific Islander—2, African American—5, Hispanic—3.

EDUCATIONAL ACTIVITIES

The goal of BPEC's educational programs is to train undergraduates, graduates, post-doctoral and industrial personnel. BPEC's vision in the educational programs is to incorporate biotechnology principles into our existing courses. This is being accomplished through course modifications and interdisciplinary teaching in the areas of chemistry, biology, and chemical engineering. The planning of our educational programs affects all sectors of the student body. To provide an industrial perspective to our students, course contents have been planned to incorporate real problems in biotechnology manufacturing. Invited lecturers from the biotechnology industry expose students to current day research problems.

To meet the goals and objectives of our educational visions, the course curricula for undergraduates graduates and industrial personnel have continually undergone changes and implemented new initiatives. For example, to integrate biotechnology concepts as well as our research thrusts, several undergraduate courses have met the above challenges. These include "Chemical Kinetics and Reactor Design" (Biochemical reactions have been included in this undergraduate core course; "Biotechnology and Bioengineering" (directly related with the center's thrusts); "Molecular and Engineering Aspects of Biotechnology" (directly related to the center's thrusts); "Chemical Engineering Project Laboratory" (directly related to the center's thrusts); "Integrated Chemical Engineering" (directly related to the center's thrusts); Interdisciplinary Research in Biomedical Engineering" (a new course integrating biology with engineering). At the graduate level in education, a large number of courses have been modified to incorporate the research thrusts from the BPEC. In addition, new courses have been implemented as a direct result of the presence of the BPEC. A summary on graduate courses presented by the BPEC faculty, relate directly to the BPEC's research thrusts: "The Folding Problem"; "Principles and Methodologies of Metabolic Engineering"; "Biochemical Engineering"; "Separation Process for Biochemical Products"; "Tissue Engineering"; "Cell Bioengineering." The BPEC faculty also taught several graduate activities and courses that provide both cross-disciplinary principles as well as systems view. Two highlights of these courses are the "Macromolecular Structure and Function Seminar" and "Seminar on Pharmaceutical and Biotechnology Industry Management."

To ensure the educational needs of industry are met, the center provided one-week special summer courses this past year. These courses included "Fermentation Technology", "Downstream Processing", "Advances in Controlled Release Technology and Delivery of Pharmaceuticals and Other Agents", and "Management for Physicians, Scientists, and Engineering in the Pharmaceutical and Biotechnology Industry"; and "Methods, Logic and Opportunities in Metabolic Engineering."

The most recent educational initiative of the center is the establishment of the "Metabolic Engineering Laboratory (MEL)" in 1995. Although still in its organizational stage that started in fiscal 1996, progress has been made towards establishing a MEL in the curriculum of the Chemical Engineering Department. The original target date of fiscal

1998 for testing the MEL is still anticipated. The National Science Foundation awarded additional administrative funding for the organization of this course.

One of the BPEC's goals is to ensure that the undergraduate students are integrated into the center's research thrusts. The BPEC provides the initial research experiences to the undergraduates and encourages the students to work in industry as internees. For example, one of BPEC's industrial coordinators contacted 49 companies associated with BPEC for summer undergraduate internships. Thirty-three contacts responded requesting résumés for summer internships: 29 contacts responded requesting résumés for permanent positions. The industrial respondents represented 19 companies/institutions.

The two main BPEC outreach undergraduate programs are the Undergraduate Research Opportunities Program (UROP) and the Research Experience for Undergraduates (REU). A total of 83 MIT UROP students participated in the center this past year. The NSF funded REU program supported 13 non-MIT students. Of this total, four of the REUs were supported by BPEC's unrestricted funds since we wish to assure our commitment toward under-represented minorities. The students were required to present their research experiences during the center's summer seminar series "UROP and REU Seminar." They were taught basic research and presentation tools during a "How to Give a Presentation" workshop series. As part of the student's research training, the BPEC instilled cross-disciplinary and team research in each student. All BPEC students were required to participate in the center's seminar series on Scientific Integrity that was lead by academic and industrial speakers.

Two BPEC faculty members presented lectures and conducted laboratory tours as part of MIT's High School Teachers Program in Science and Engineering. At these lectures, the goal is to excite the teachers with new developments in biotechnology. A teacher from the Hebron Academy School in Hebron, Main, after hearing the lecture, worked with BPEC to arrange a follow-up visit by 11 students to the BPEC. In addition, BPEC faculty participated in the Annual Lecture Series for High School Students held at MIT in February 1997. Previous graduates of the BPEC led panel discussions on the exciting future of biotechnology and nine biotechnology companies sponsored the lecture series. Five of these companies have been or are presently affiliated with the BPEC.

This center also has an outreach research program to other universities. Three of BPEC's faculty members are not from MIT; these other home institutions are Purdue University (F.E. Regnier), Iowa State University (C.S. Lee) and Massachusetts General Hospital (Martin L. Yarmush). Research programs at these different universities are integrated in the center's programs. In addition, students from these universities have spent time during fiscal 1997 summer months in BPEC labs; in addition, the center's students, too spent time at these other universities.

At the graduate level, the center continued to bring interdisciplinary ideas into the course teachings. BPEC successfully completed the seventh year on the NIH Interdepartmental Biotechnology Training Program (BTP) which was officially inaugurated in 1989. Funding for this program is provided by the NIH-NIGMS and was renewed for an additional five years of funding effective July 1, 1994. This program is organized to train 20 Ph.D. students to become providers for the scientific and engineering talent and leadership needed to maintain the growth phase of the new industry, and to educate the next generation. Twenty-five faculty members from MIT are involved, representing the Departments of Biology, Chemistry and Chemical Engineering. Professor Daniel I. C. Wang, the center's director, is also the director of this program. Professor Jonathan A. King, a professor in the Department of Biology, is program chair.

Nearly 75% of our graduates enter industry. At a time when industrial hiring has decreased in other disciplines, we have not found this to be the case for our graduates because of the training that we have provided in biotechnology process engineering. To ensure the educational needs of industry are met, the center has provided one-week special summer courses achieved through the Special Summer Course Program at MIT. In fiscal 1996, four special summer courses under the auspices of the BPEC were presented.

Our educational advances have had an impact on both undergraduate and graduate students through the cross-disciplinary courses that will broaden the students' knowledge base for entering industrial biotechnology sectors. Especially significant to undergraduates, our educational activities have penetrated their curriculum and enhanced their interest in future careers in biotechnology. The potential of this new breed of students represents a real benefit

to industry. On the graduate level, the significance of our research thrusts have been incorporated into new courses which will expose these candidates to important needs required to solve problems facing the biotechnology industries, as well as their possible future careers in academia. It is our belief that students are our most valuable product and that our training programs have provided a cadre of leaders for tomorrow.

CURRENT RESEARCH

The vision of the BPEC is to promote the success of the US biological industry by being pioneers and leaders to the academic, industrial and government communities in the planning and implementation of research and education. This visionary approach is especially important in the field of biotechnology since scientific breakthroughs are constantly occurring breakthroughs which in turn affect the technological aspects of manufacturing. Our vision for the past 12 years has not changed insofar as we have continually predicted and reaffirmed the importance of therapeutic proteins for the biotechnology and biopharmaceutical industries. The research thrusts of the BPEC have continued to focus on the original vision: the production of complex therapeutic proteins. However within each thrust new concepts have been added due to the completion of some of the previous goals. BPEC presently has two main thrusts in research education and industrial involvement: Thrust I. Therapeutic Protein Production: Quantity and Quality; and Thrust II. Therapeutic Protein Aggregation, Stability, Formulation and Delivery.

The research in Thrust I is organized into four subareas: 1. Method development: including laboratory analytical techniques, as well as information analyses, such as Metabolic Flux Analysis, material and energy balances. 2. Glycosylation: including microheterogeneity, macroheterogeneity, and genetic modification of glycosylation processing. 3. Apoptosis: including environmental effects, manipulation of genetic controls and cell physiology. 4. Process Operations: including medium design/process control, and sparging/scale-up of bioreactors. One of the purposes for the creation of this thrust area is to provide an integrated approach and a systems view of the research. We have adopted a virtual toolbox concept for the research activities within the thrust area. These tools are available for the use of all researchers who need them for their work. In addition, the tools and methods we develop and publicize are available to the industrial members of the Consortium by request. The transfer of these methods and techniques offers opportunities for direct interactions between industry and the researchers.

The research in thrust area II addresses stability, formulation and delivery. Protein aggregation is important in product stability, protein folding/refolding, disease state (amyloids) and vaccine virulence. The second subthrust focuses on the structure of solid protein formulations and the effects of bioprocessing parameters on protein stability. The mechanistic understanding of structure-function relationships allows us to examine possible methods to stabilize proteins through the rational incorporation of excipients. A technology-based milestone has also been achieved in addressing the parameters that affect protein stability in lyophilization process. The milestones in protein stability have already been transferred to various industrial collaborators. The last areas of research focuses on delivery systems for macromolecules. The objective of our research is to devise new and novel means for the delivery of macromolecules such as therapeutic proteins.

INDUSTRIAL COLLABORATIONS AND TECHNOLOGY TRANSFER

The industrial interactions during fiscal 1997 were achieved through both knowledge-based and technology-based advances. Industrial collaborations and technology transfer are important goals of the center. In the past the BPEC's Industrial Advisory Board, met once a year. Therefore, in fiscal 1997, members of our research Consortium replaced the earlier Industrial Board. The reason for this replacement was the research Consortium's better knowledge of the center's activities. Thus we believe the Board as it now stands is able to provide better advice and planning to the center. In addition to this Board, the center's Research Managers have shorter-range goals and objectives with specific issues and defined technological barriers within their organization. These managers serve as a very important function to the BPEC: they serve as champions of the BPEC in their collaborations with the company's upper management.

The center's Cell Culture Process Optimization Consortium was expanded during fiscal 1997 to include all the center's research. The Director of this consortium is Professor Gregory N. Stephanopoulos. All of the BPEC faculty members are part of the Consortium. There are presently 13 companies in this Consortium, each of which contribute \$25,000 per year for two years. There are two annual meetings, each 1_ days in duration. The benefits to the Consortium members include: participating in the planning of the center's research; serving on doctoral thesis committee of students; semi-annual reports on the center's research progress; licensing rights to research findings;

access to BPEC facilities and personnel; direct technology transfer and testbeds at BPEC or company sites. The BPEC interface with the consortium members is achieved through the consortium coordinator, Dr. James Leung.

Responsibilities of the BPEC's Industrial Consortium Office include coordinating company visits; distributing research abstracts, published papers, and student theses; organizing workshops and symposia; and maintaining a database of BPEC research projects. This office works closely with the BPEC faculty, BPEC students, the MIT Industrial Liaison Program, and the MIT Technology Licensing Office to serve company needs in addition to this research consortium, the BPEC also collaborates with industry through other means. There are often very specific collaborations between a given BPEC faculty and a given company. Formal collaborations through these efforts are achieved via grants and contracts directly to the participating faculty. A total of 38 companies collaborate with the BPEC in its two research thrust areas. It should be noted that some companies collaborate on more than one project.

A further indication of the significance of the BPEC to industry is the large number of US companies that have visited the center. These visits represent the interest the biotechnology industry exhibits in learning about the cutting-edge research that we believe is important to the industrial sector today and will be tomorrow. Fifty US companies visited the BPEC this past year.

A useful method of demonstrating the center's industrial collaboration is by presenting the actual transfer of technologies to companies by the center. Twenty-two companies were recipients of technologies transferred from the BPEC during fiscal 1997.

There are several ways in which advances in technology can be reported. The knowledge-based information research represents one facet of technology transfer. Publications, presentations, and seminars present this type of information transfer.

The center faculty presented 32 industrial seminars reaching an attendance of 1,751. In addition, the faculty made 97 technology-based presentations to societies, conferences, and symposiums; presented 67 seminars for academia; and published 178 BPEC thrust related publications.

Another example of significant advances in technology transfer is based on patents arising from the research in the center. Patents represent novel and new concepts and can be considered to be an effective means for transfer technology. The BPEC faculty filed eight patents during fiscal 1997; 22 of these patents were granted; and one was licensed.

More information about this center can be found on the World Wide Web at the following URL:
<http://web.mit.edu/bpec/>

Daniel I. C. Wang

CENTER FOR INNOVATION IN PRODUCT DEVELOPMENT

The mission of the Center for Innovation in Product Development (CIPD) is to advance the theory and practice of product development by combining the best ideas and experience of industry and academia. Through the Center's research and education activities, we are exploring new ways to identify market opportunities, understand customers, and manage processes. We are searching for innovative approaches to defining, designing, and delivering products and services.

The Center, an interdisciplinary program between the School of Engineering and the School of Management, was created this year with funding from the National Science Foundation and collaborating corporate sponsors. Research in the Center is being conducted in four major areas. The first research area, "Defining Successful Products," is led by Xerox Fellow in Product Development, Don Clausing. Faculty and students in this research area have started working to answer questions such as: What processes will help industry best identify high-value products that truly meet customer needs? Through this research, the Center will strengthen the ability of companies not only to define outstanding products, but to ensure long-term success and profitability with those products.

The second area of research involves "Information-Based Development." Led by Associate Professor of Management Science Stephen Eppinger, faculty and students in this research area are seeking to determine what the phrase "information revolution" means for product development. By creating more effective information-based tools to support product development activities, the Center will help practitioners do their work more effectively and with greater efficiency.

"Enterprise Strategy," the third area of research, is led by Management Associate Professor Rebecca Henderson. She is working with faculty and students in this area to determine the relationships among the market environment, corporate capabilities, and product strategy. The Center's research here will explore potential improvements in enterprise strategy that can strengthen the product development process.

The final area of research, "Accelerating Capabilities Improvement," is led by Visiting Scholar David Bell of the Xerox Corporation. Questions of interest to this team are, "How can companies best benefit from research in product development?" and "How can a network of learning communities be created which spans academia and industry?" Faculty and students working in this area are studying and developing new tools and methods which will enable companies to absorb best practices, both established and emerging, with greater speed and efficiency.

In the near future, the Center will start to test its results continuously by means of collaborative projects at member companies. Research in the Center has begun with the development of hypotheses to be tested. Partner companies are being identified as research sites. Information, which will be gathered on site, will then be brought back to MIT by our students, faculty, and industrial colleagues, who will develop ideas, software and other representations of their work which will then test the hypotheses. Testing, evaluation and demonstration will occur both at MIT and at member company sites. Follow-on projects will include commercialization activities with other companies whose business is to develop and sell product development tools and methods. These could be firms in the Computer-Aided Design industry or management consulting firms.

The Center's management currently includes the Director, Warren Seering, Weber Shaughness Professor of Mechanical Engineering, and Research Director, John R. Hauser, Kirin Professor of Marketing. Center management also includes the Director of Industrial Collaboration, Kamala Grasso, and the Director of Finance and Administration, Jo-Anne Lema. Currently twenty-four faculty members, including the Center's Director and Research Director, are engaged in research related to the objectives of the Center.

Warren Seering

CENTER FOR TECHNOLOGY, POLICY, AND INDUSTRIAL DEVELOPMENT

The Center for Technology, Policy, and Industrial Development was founded in 1985 to foster teaching and research focused on policy issues related to science and technology. The Center was established in response to the realization that as technology proliferates it effects profound and pervasive changes in our economic system and its component industries, changes that intensify the fundamental complexity of our lives. This growing complexity challenges us to develop policies that will allow us to enjoy the benefits of that technology and at the same time will protect us against its possible harmful side effects.

The Center's goal is to understand the effect of technological changes on the development of society and to help formulate policies for an era of intensified international economic competition. It works to accomplish this goal through an active and rigorous academic program and by overseeing research activities that incorporate many disciplines.

One major focus of these research activities consists of industry study programs that investigate particular industries like the automotive and aerospace industries. Below is an overview of these study programs, highlights of the Center's other research activities, and descriptions of the Center's academic programs.

INTERNATIONAL MOTOR VEHICLE PROGRAM

The International Motor Vehicle Program (IMVP) is a multidisciplinary research enterprise that performs comprehensive studies of the automobile industry worldwide, including its effect on society. The research has followed two courses: One examines automobile manufacturing by identifying the best practices, assessing industry performance standards, and developing international comparisons of assembly plants, suppliers, and distributors. The other research track examines the place of the automobile in society, exploring such issues as the environment, automobile regulation, and a variety of cooperative relationships evolving between management and labor and between business and government.

In the past year, the IMVP has been synthesizing its various research projects, considering the evolution of the world auto industry from three vantage points:

- The changing power dynamics within the industry;
- The search for a socially and economically feasible vehicle; and,
- The integrated management of the enterprise of automobile production.

A writing team has been formed to present the outcome of this synthesis in a follow-on book to the IMVP's best-seller, *The Machine That Changed the World* (1990). The IMVP continues its collaboration with a number of affiliate programs, including the International Car Distribution Programme, based in Great Britain.

The IMVP this past year has completed a working version of Auto Case 2000, an interactive software-driven simulation model for exploring outcomes of different automobile manufacturing strategies. This model has been used in classes at the Sloan School of Management and has been tested by several IMVP industry sponsors. The software package has been prepared for distribution to all IMVP sponsors in the coming year. Co-Directors for the IMVP are Profs. Daniel Roos and Charles Fine. Research Director for the IMVP is Dr. Frank Field III.

LEAN AIRCRAFT INITIATIVE

The Lean Aircraft Initiative (LAI) analyzes how the "lean" paradigm, identified by the International Motor Vehicle Program for the auto industry, can translate into the U. S. defense aircraft industry. This industry currently faces multiple consolidations, massive spending cuts, and yet also a dire need to provide the operating defense forces with sophisticated, technologically superior products. LAI brings together the industry's principle stakeholders: the aerospace companies, government, and labor. Now in its second three-year phase, LAI is working toward a vision of significantly reducing the cost and cycle time for military aircraft throughout the entire value chain while continuing to improve product performance.

In this first year of phase II the LAI consortium membership jointly defined the Initiative's research priorities for each of four focus areas and three product teams. This research plan was then put into action. Two of the teams were new: the Implementation Integrated Product Team, whose concern is making possible and facilitating enterprise-wide systemic change; and the Communications Integrated Product Team, whose concern is helping to build awareness and understanding of lean principles and practices inside the LAI community. Also, based on research begun earlier, the Policy and External Environment Focus Team presented findings about program instabilities that resulted in LAI policy recommendations to the Office of the Undersecretary of Defense, Acquisition and Technology.

Additionally, several government agencies and private companies became new Sponsors of LAI. From government these were the C-17 Systems Program Office, the F-22 Systems Program Office, the Joint Strike Fighter Systems Program Office, the U.S. Coast Guard Office of Engineering, Logistics & Development, and the U.S. Department of the Navy, Naval Air Systems Command (NAVAIR); while from industry new Sponsors were the Allison Engine Company, Applied Materials, Inc., the Hewlett-Packard Company, and Litton Industries.

LEAN SUSTAINMENT INITIATIVE

The Lean Sustainment Initiative began this year. The sustainment of military operating forces involves the maintenance, repair, and re-manufacturing of military aircraft. In a decreasing defense budget environment it is essential to reduce costs so that sustainment is affordable while procurement authority remains free to pursue required system upgrades and new systems. The current military operating environment is one of constrained resources while yet having flexible global operational requirements. The goal of the initiative is to identify and define those lean principles and practices that will help achieve significant cost savings, greater efficiency, and higher quality in the effort to provide responsive logistics and sustainment support to the flightline customer. The study effort will likely lead to a three-year collaborative program between the Air Force and MIT.

LEAN SPACE INITIATIVE

A "Quick Look Study" was made this year to determine the feasibility of establishing a Lean Space Initiative similar to the Lean Aircraft Initiative. The defense space business faces significant challenges: the timely adoption of new technology, the need for efficient space launch operations, and the need to build specialized products in a lean manner. The Lean Space Initiative would undertake data-driven research in the space industry with the goal of finding ways to significantly reduce the cost and cycle times for space military assets throughout the value chain—while continuing to improve product performance. Through a comprehensive survey of potential stakeholders and an analysis of the applicability of space-particular problems to ongoing Lean Aircraft Initiative research, the study team concluded that a Lean Space effort should be initiated as a "space sector" within the Lean Aircraft Initiative. This recommendation has been accepted by the Air Force and steps are being taken to obtain approval within the membership of the Lean Aircraft Initiative.

FAST AND FLEXIBLE COMMUNICATION PROJECTS

The Fast and Flexible Communication Projects are part of an ongoing government initiative to improve U.S. manufacturing capability and analyze product-development in the automotive and aerospace industries, focusing particularly on the relationship between complex assemblies and multiple sources for parts and tooling. Originally designed as a 28-month project in 1994, the research has been extended to January, 1998, and now comprises two sections: the Fast and Flexible Communication of Engineering Data in the Aerospace Industry, and the Fast and Flexible Communication Design and Manufacturing Systems for Automotive Components and Sheet Metal Parts.

The Projects' research efforts have focused on developing more "agile" or "fast and flexible" communications and processes. One component of the research includes hypothesis-testing of agile manufacturing principles developed by the Agile Manufacturing Forum at Lehigh University. The Projects have deployed faculty, staff, and site-located graduate students from MIT and Lehigh University at multiple sites: the General Motors Saginaw Steering Division and Luxury Car Division; Northrop-Grumman Vought Center (soon to be part of Lockheed-Martin); the Boeing Commercial Aircraft Group, the sites at Renton and Everett, Washington; and the Ford Motor Company Body and Assembly Operations in Dearborn; the Ford-Louisville Assembly Plant and a primary sheet metal supplier, Budd Company; and the Ford Electronics Division. Co-Directors for the projects are Prof. Charles Fine and Dr. Daniel Whitney.

INTERNATIONAL COOPERATIVE MOBILITY RESEARCH PROJECT

The International Cooperative Mobility Research Project's objective is to improve our understanding of world motorization as a phenomenon, help implement policies to alleviate the problems increased motorization may bring, and facilitate the opportunities increased motorization may yield. The Mobility Project provides a new vision of a sustainable multimodal transportation system. Its task is to analyze what our mobility needs and choices are through the process of collecting data worldwide and comparing how certain policy and technology approaches have worked in facilitating mobility.

Now in its initial stages, the Mobility Project has begun work in establishing the International Mobility Observatory, an effort to identify, evaluate, and document outstanding examples of innovative mobility systems and strategies around the world. The project team met twice—once with sponsors and once with only researchers—and has produced a compendium of noteworthy mobility initiatives.

RESEARCH PROGRAM ON COMMUNICATIONS POLICY

The Research Program on Communications Policy (RPCP) at CTPID has the following objectives: To study technical, economic, and policy challenges to open interfaces for scalable digital systems and broadband networks; to facilitate dialogue on these issues across industries, across government agencies, and across academic disciplines; to disseminate the results of these activities.

Major RPCP projects developed over the past year and continuing into 1997 include:

- the Internet Telephony Interoperability Consortium, an international research organization focused on the convergence of the Internet and traditional telephony;
- investigating the policy implications of an MIT-developed television camera (now manufactured by Polaroid) which could reshape a Federal Communications Commission ruling over a broadcasting standard for high-definition television;
- the Dual Use Education and Training (DUET) Server Acquisition and Local Access research projects.

The Internet Telephony Interoperability Consortium (ITC) developed into an independent operation this year. More information about the Consortium appears below as a separate entry of this Report.

The MIT-Polaroid camera is the world's first progressive-scan high-resolution production-quality video camera. It is capable of shooting 60 frames per second as opposed to the standard movie format of 24 frames per second, and it is compatible with both film and computer requirements. Its progressive scan technology offers the best interoperability with digital processing and meets the proposed standards for high definition television (HDTV)—an accomplishment that was not thought to be technically feasible at present. The success and praise of the camera were major factors in recommendations to reevaluate the HDTV proposal before the FCC.

The DUET Server Acquisition research project is part of an extensive program to move US Army documentation and training systems online and to improve those systems with interactive multimedia and graphically rich formats. The DUET Local Access research project established technical, business, and policy criteria for achieving effective local access to interactive multimedia content in the information infrastructure. This effort has led to the recognition of local access as a critical technical, economic, and policy issue that needs to be resolved if the average consumer is to have efficient, effective, and inexpensive access to the full information infrastructure.

INTERNET TELEPHONY INTEROPERABILITY CONSORTIUM

The Internet Telephony Interoperability Consortium (ITC) works on technical, economic, strategic, and policy issues that arise from the convergence of telecommunications and the Internet. The ITC is comprised of member companies and academic researchers who work collaboratively to understand and shape future technologies, industry and market structures, and regulatory policies worldwide. The ITC seeks to be a neutral forum in which members—who represent the various interests associated with the Internet, Internet telephony, and the telecommunications industries—may discuss these issues and benefit from cross-industry communication. The ITC's long-term goal is to enable the growth of new forms of mediated, integrated, multimedia communication that spans the Internet and the telecommunications infrastructures.

MATERIALS SYSTEMS LABORATORY

The Materials Systems Laboratory (MSL) is internationally recognized for its innovative work on the competitive position of materials and the strategic implications of material choice for automotive, electronic, and aerospace applications. Its 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.

MSL has been particularly successful in developing an understanding of the cost of using new materials and materials processes—such as powdered metals and tailor-welded blanks in sheet metal stamping—in a wide range of applications and contexts. Three continuing research projects for MSL in 1996 have been (1) establishing the impact of automobile technology upon the development of materials, (2) identifying new trends in automobile materials, and (3) developing tools to facilitate the use of life cycle analysis in materials selection decisions. Director for MSL is Dr. Frank Field III.

TECHNOLOGY, BUSINESS AND ENVIRONMENT PROGRAM

The Technology, Business and Environment Program was founded to help companies meet the dual challenges of achieving environmental excellence and business success. The Program's mission is to elucidate a new preventive environmental management paradigm, centering on business practices and linking technological change with sound environmental management.

Two major projects for TBE in 1996 had been (1) a research initiative to study the ways companies are adopting non-regulatory codes of environmental management; and (2) a set of studies looking at the adoption of tools and guidelines for introducing environmental themes into a company's products and processes. Director for TBE is Dr. John Ehrenfeld

TECHNOLOGY AND LAW PROGRAM

The Technology and Law Program offers a cluster of graduate-level courses within the Technology and Policy Program at MIT as well as research opportunities at the interface of law and technology. Research activities in 1996 included the design and evaluation of policies for: encouraging technological change that would prevent chemical accidents and pollution through regulation, liability, and economic incentives; promoting environmental justice through involving communities in governmental and corporate decisions that affect their health, safety, and environmental concerns; and investigating sustainability, trade, and the environment. The Program's director is Nicholas Ashford.

TECHNOLOGY AND POLICY PROGRAM

The Technology and Policy Program educates men and women for leadership on the important technological issues confronting society. TPP prepares its graduates to excel in their technical fields and to develop and implement effective strategies for dealing with the risks and opportunities associated with those technologies. TPP's primary efforts concentrate on the Master of Science Program, which prepares students for practical work in government and industry. An integral part of the TPP curriculum is a Summer Internship Program. This year it placed over 30 interns in major policy centers in the United States and abroad. With about 150 students on campus and approximately 600 graduates, TPP is now the largest program of its kind in the world. Students require between one and two years to complete the degree, which includes an interdisciplinary thesis focused on a Technology Policy issue.

TPP also conducts an active international outreach program. This year new associations were initiated with the Technical University of Delft (Netherlands) and the Instituto Superior Tecnico of Portugal. The two institutions join many other universities and educational agencies with which the program actively maintains relations, particularly in France, the United Kingdom, and Japan.

Also noteworthy this year were the achievements of Program graduate Elizabeth Stock, who was elected to the MIT Corporation as a Representative of Recent Graduates, and, was named by President Clinton to be a White House Fellow assigned to Vice President Gore. Chairman for TPP is Prof. Richard de Neufville.

MIT COMMUNICATIONS FORUM

The Communications Forum is an interdisciplinary seminar series that reviews the full range of communications-related issues. The topics include developments in communication technology, the economics of the telecommunications markets, and regulations in the communication industry—just to name a few. Sessions are held approximately every two weeks.

During 1997-99 the Forum will undertake the "Media in Transition" project, a major initiative funded by the Markle Foundation. The project will involve lecture series, international conferences, panel discussions, and Internet activities centered on emerging communications technologies. An experimental web site has been mounted in connection with the project: <http://media-in-transition.mit.edu>. Director for the Forum is Prof. David Thorburn.

CTPID

The Center for Technology, Policy and Industrial Development has an extensive Internet site at "<http://web.mit.edu/ctpid/www>", where one can attain research papers and more information about its program groups and personnel.

Daniel Roos

CENTER FOR TRANSPORTATION STUDIES

The Center for Transportation Studies 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.

The Center's Web address is <<http://web.mit.edu/cts/www>>. In addition to a wealth of information about the Center and its programs, 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

Because the quality of applications remains consistently high, qualifying for graduate admission for transportation studies is increasingly difficult. This year, 71 applications were received for graduate studies in transportation, and 20 students were enrolled. Funding was found for 60% of the students.

In December, 48 undergraduates from around New England came to MIT to learn about graduate transportation programs at MIT and Harvard and at the Universities of Massachusetts, Connecticut and Rhode Island. The open house event was sponsored by the Region One UTC Program (headquartered at the Center), of which those schools are all a part.

This spring, the faculty voted to approve the initiation of a new nine-month program leading to a Master of Engineering in Logistics, to be administered by the Center. Scheduled to admit its first students in the fall of 1998, the full-time course of study will be the first of its kind to produce logistics professionals with a system-wide, cross-functional perspective who are equally at home with sophisticated data analysis. Designed as an interdisciplinary effort in the School of Engineering, the program will be offered in cooperation with several departments and organizations within MIT, including the Sloan School of Management and the Center for Advanced Educational Services. Enrollment is expected to reach a steady-state of 60 students by the fifth year.

RESEARCH

During the past academic year, 150 projects were listed in the Center's Current Research Projects in Transportation at MIT, 47 of which had been started since last year's listing was printed. Sponsored research volume remains level.

MAJOR NEW PROJECTS

The Morgan State University research considers the CVO component of Intelligent Transportation Systems and how it should be deployed in Maryland, which is a prototype CVISN state as designated by the FHWA. Issues of technology, systems and institutions will be integrated into a strategic deployment plan. This work is being performed in a cooperative program with Morgan State University and the Advanced Physics Lab of Johns Hopkins University. Sponsored by the Federal Highway Administration, US Department of Transportation.

The major objectives of the proposed project with the Massachusetts Highway Department are the application of DynaMIT, a simulation-based Dynamic Traffic Assignment (DTA) system to the Eastern Massachusetts freeway and arterial network in an off-line mode (the application will have the potential to serve as the foundation for an on-line travel information system in the future); the utilization of the implemented DTA system to design a library of Variable Message Sign (VMS)-based strategies for route diversion in response to incidents; and the utilization of the implemented DTA system to evaluate the effectiveness of the generated strategies in terms of travel time, congestion relief, and information reliability.

The Center for Transportation Studies at MIT has selected this project with the MBTA to receive Federal funding as part of the US DOT New England Region University Transportation Centers Program. This program operates on a one-to-one dollar matching basis with the match typically being provided by the public agency which would benefit most directly from the work. This project will develop a decision support system for non-routine or emergency operations on rail transit systems. It has been developed in conjunction with the MBTA and is specifically tailored to take advantage of the new functions and capabilities available with the new Operations Control Center.

Optimization of Railroad Blocking Plans. (Cynthia Barnhart). On major domestic railroads, a typical general merchandise shipment may pass through many classification yards on its route from origin to destination. At these yards, the incoming traffic is sorted and grouped together to be placed on outgoing trains. The classification process is time, labor and capital intensive since many workers and large quantities of equipment are needed to sort the traffic. To reduce the number of reclassifications, several shipments may be grouped together to form a block. A block has associated with it an origin-destination pair which may or may not be the origin-destination pair of any of the individual cars contained in the block. Once a shipment is placed in a block it is not reclassified until it reaches the destination of that block. We develop optimal or near-optimal blocking plans through the use of large-scale network-based optimization models. These models are designed to capture the global network effects of blocking decisions at each yard. Sponsored by CSX Transportation.

INTEGRATED SUPPLY CHAIN MANAGEMENT PROGRAM

Since its inception in Fy 95, the MIT/Industry Integrated Supply Chain Management Program currently has eight members -- Amoco, Caliber Logistics, Monsanto, Procter & Gamble, Quelle, Siemens, Volkswagen, and Xerox. To date, sixteen research projects have been initiated, eleven quarterly collaboration meetings have been held at sponsor locations, and the second annual executive seminar has been conducted, attracting over 35 senior managers from sponsor companies for a two-day session.

MAJOR MEETINGS

In December, nearly ninety people representing 44 different organizations convened at the MIT Faculty Club for a two-day meeting focused on the challenges and opportunities facing global logistics practice. Sponsored by the Center's Corporate Affiliates Program, the seminar drew an unusually diversified crowd from the private and public sectors and from academia, in 21 states and four foreign countries, to take part in discussions of presentations on a range of global logistics issues.

In January, over thirty senior executives from the members of MIT's Integrated Supply Chain Management Program convened at the MIT Faculty Club for a two-day meeting on the application of supply chain design, organization and technology for competitive advantage. The purpose of the meeting was to bring executives together with MIT faculty and other sponsors to share the latest learning's in supply chain management. Member companies represented were Amoco, Caliber Logistics, Monsanto, Procter & Gamble, Quelle, Siemens, Volkswagen and Xerox.

In February, 65 people from 25 different organizations convened at MIT's Faculty Club for a two-day seminar on "Freight Terminals: Operations and Customer Service." The purpose was to bring together people involved in freight terminals -- for railroads, trucks or ports, for big or little packages -- to talk about operations and customer service. To the organizers' knowledge, it was the first such conference focused specifically on terminals and certainly the first at which people from trucking, ports and railroads were all convened in the same room talking about their problems in detail.

In May, nearly sixty people attended a two-day conference on transportation safety at the MIT Faculty Club, sponsored by the Center's Corporate Affiliates Program. The conference was organized to explore some leading issues in transportation safety, focusing specifically on commercial transportation, primarily trucking and rail.

SMALLER FUNCTIONS

As usual, the Center sponsored a reception at the annual Transportation Research Board meeting in Washington in January. This year's event was attended by about 50 alumni and friends.

Every semester the Center sponsors a luncheon seminar series featuring transportation experts from the public and private sectors, and from academia, discussing current issues in the transportation field. Open to the public at large, the seminars draw an audience made up not only of students and faculty from the Institute, but also of representatives from the Volpe National Transportation Systems Center in nearby Kendall Square, from other universities, and from business and research organizations in the area.

Last fall, the series featured Thomas Downs, Chairman, President, and CEO: Amtrak; Ann Canby, Secretary of Transportation: Delaware Department of Transportation; Gordon Bethune, President and CEO: Continental Airlines; and David Winstead, Secretary of Transportation, Office of the Secretary: Maryland Department of Transportation. The spring series included Damian Kulash, President and CEO: Eno Transportation Foundation, Inc.; Thomas Cook, President: SABRE Decision Technologies; and David Calhoun, President and CEO: General Electric Transportation Systems.

A new series of luncheon seminars was introduced last year featuring MIT faculty and research staff presenting their current work for discussion and feedback. Participants in the series this year were:

Peter Belobaba, Associate Professor, Aeronautics & Astronautics; David Gordon Wilson, Senior Lecturer and Professor Emeritus, Mechanical Engineering; Robert Fogelson, Professor, Urban Studies & History; Karen Polenske and Alvaro Pereira, Professor and Ph.D. Candidate, Urban Studies and Planning; Michel Bierlaire, Research Associate, Intelligence Transportation Systems Program; Mark Hanson, Associate Technical Staff, Air Traffic Automation Group, Lincoln Laboratory; Carl Martland, Senior Research Associate, Civil and Environmental Engineering; Alan Chachich, Research Scientist, Center for Transportation Studies; Herbert Einstein, Professor, Civil & Environmental Engineering; Lee Grodzins, Professor, Physics; Ian Savage, Professor, Department of Economics, Northwestern University; Ennio Cascetta, Professor, Department of Transportation Engineering, University of Naples, Italy; Michael Florian, Research, University of Montreal; Bob Simha, Director of Planning, Planning Office; Michael Cassidy, Professor, Department of Civil and Environmental Engineering, U. Cal. Berkeley; Don Pickrell, Chief Economist US DOT, Volpe National Transportation Systems Center.

Peter Klaus, Professor of Business Logistics at the University of Erlangen-Nurnberg, was a Visiting Professor in the Center for Transportation Studies this spring, conducting research as part of the Integrated Supply Chain Management Program, and on other logistics topics, through the end of April. While here, he gave a series of six lectures on logistics.

CORPORATE AFFILIATES PROGRAM

The Corporate Affiliates Program welcomed several new members this year, bringing the current total membership to 35. The new members are Crowley Maritime; Emery Worldwide; Osram Sylvania; P & O Nedlloyd; Sabre Decision Technologies; Sony; and Wisconsin Central Ltd. Continuing members are British Airways; Canadian National; Canadian Pacific Railway; Caterpillar; Conrail; CSX Transportation; Cummins Engine; DuPont; Federal Express; General Electric; Gillette; Goodyear Tire & Rubber; Home Depot; Honda; International Business Machines; LogiCorp; Mars; Monsanto; NYK; Procter & Gamble; Ryder System; Sea-Land Service; Unilever; Union Pacific; United Parcel Service; United States Postal Service; Volkswagen; and Yellow.

Every year, as part of the Center's Corporate Affiliates Program, one of the members hosts the rest of the group at a two-day meeting and tour of one of its facilities. This year, in September, nearly 70 representatives of 43 organizations convened in Watsonville CA, between Santa Cruz and Monterey, for the latest Affiliates Day at Skyway Freight Systems, a subsidiary of Union Pacific Corporation. The subject of the meeting was "Technology-Based Logistics Solutions" -- the first day focused on technology, the second on customer case studies.

PROFESSIONAL EDUCATION

Every summer for the past twelve years, the Center has offered an intensive week-long seminar on Logistics Analysis for Carriers and Shippers. Attended by representatives of carriers, shippers and third-party logistics providers, the course is structured around a series of lectures and case studies and involves intensive interaction among the participants. This year the course was attended by 60 participants.

PERSONNEL CHANGES

Personnel changes in the Center this year include the departure of Patrick Little, Marygrace Filippone, Peter Welch, and Amanda Bourque, and the hiring of Michel Bierlaire, Didier Burton, Janet Kerrigan, Sydney Miller, and Qi Yang. The Center was also joined this past year by Professor Peter Klaus, a Visiting Professor from Germany.

RECOGNITION

Moshe Ben-Akiva, a long-time member of MIT's transportation faculty, was named the Edmund K. Turner Professor of Civil and Environmental Engineering, effective September 1. Ben-Akiva has been teaching in the

Department of Civil and Environmental Engineering since 1973, as part of the transportation division. His teaching interests have focused on demand modeling and econometrics, and he has been conducting research in transportation systems analysis, intelligent transportation systems, demand modeling, econometrics and infrastructure management.

The Center's Doctoral Dissertation Research Fellowship for 1996-97 was awarded jointly this year to Sarah Stock and Owen Chen. A doctoral student at MIT's Operations Research Center, Sarah Stock is writing her dissertation on "Dynamic Flow Management Techniques Applied to Air Transportation Problems." Professor Dimitris Bertsimas is chairman of her doctoral committee. Owen Chen is a doctoral student in the Center for Transportation Studies; his dissertation is focused on "Integration of Traffic Assignment and Traffic Control." Professor Moshe Ben-Akiva is chairman of his doctoral committee. Made possible by a grant from the UPS Foundation, the doctoral fellowship covers full tuition and a full-time graduate assistant stipend for nine months.

In recognition of outstanding contributions to the betterment of society, Arnold Barnett, Professor of Operations Research and Management in the Sloan School of Management, and a sometime participant in the Center's efforts, was presented in November with the President's Award by the Institute for Operations Research and the Management Sciences (INFORMS). Barnett has been a major contributor to many fields -- including aviation safety, criminal justice, race relations, war-casualty patterns and the misuses of statistics in the social sciences.

Transportation student Lisa Klein (MST'97) was named the winner of the 1996/97 National Student Award for Region One of the University Transportation Centers Program. Her selection was based on a competitive process that included all eligible students who receive financial support from the New England University Transportation Center. The judges chose Klein for her outstanding academic record, her unique leadership qualities, her professional ability and her paper entitled "Parking Cash-Out as a Transportation Demand Management Tool and a Potential Application in Cambridge Massachusetts."

Five faculty members associated with MIT's Operations Research Center, all of whom work from time to time on transportation issues, were awarded chairs this year in their respective departments: Dimitris Bertsimas was named as a Leaders for Manufacturing Professor at the Sloan School of Management; Robert Freund was named the Seley Professor of Management at the Sloan School of Management; Amedeo Odoni was named the T. Wilson Professor of Aeronautical Engineering in the Department of Aeronautics and Astronautics; James Orlin was named the Penn Brooks Professor of Management at the Sloan School of Management; and Lawrence Wein was named as a Leaders for Manufacturing Professor at the Sloan School of Management.

This spring, Professor Thomas Sheridan received the 1997 National Engineering Award from the American Association of Engineering Societies. The award is presented "to recognize an engineer whose career and accomplishments have particularly benefited humanity." Dr. Sheridan is professor of engineering and applied psychology in the Department of Mechanical Engineering and is also a professor in the Department of Aeronautics and Astronautics. He researches human/machine systems and human factors in transportation.

Qi Yang, of the Center's sponsored research staff, was selected as one of 35 finalists in the 1997 *Discover Magazine* Awards for Technological Innovation for his work on the Microscopic Traffic Simulator. Almost 4000 innovators were invited to participate in the program this year, producing a vast selection of entries in each of the categories. The magazine's editorial staff narrowed the entries to 35 finalists, all of which were featured in the July 1997 awards issue of *Discover Magazine*.

Yossi Sheffi

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 64 students) and extensive personal interaction with senior faculty and tutors provide students with the intimate atmosphere of a small school while retaining all of the excitement and resources of a large institution like MIT.

62 freshmen enrolled in Concourse for fall term which represented a 7% increase over the fall of 1995. Spring term's enrollment was 32, a 32% decrease from the spring of 1996 but also virtually identical to the spring registration in 1995.. Registration for IAP 1997 was limited to fourteen students who participated in Concourse's twelve-unit course on problem solving, a 56% increase over IAP 1996.

The success of SP330, "The Meeting of Art and Science Through Method" and SP344, "Problems in Electricity and Magnetism," both first offered last year, continues into the second year. "The Chicken From Minsk," a book based on SP345, continues to receive favorable public recognition: by Roger Penrose in the September 27 *Times* Higher Education Supplement, and by Karen Johnson in the *Annals of Improbable Research* (vol. 3 #2).

Members of the Concourse faculty for 1995-96 were: Professor Robert M. Rose, Department of Materials Science and Engineering; Professor Judah L. Schwartz, School of Engineering and Harvard School of Education; Lior Pachter and Harry L. Wolfgang, Department of Mathematics; Dr. Jeremy Wolfe, Department of Brain and Cognitive Science; Dr. Yuri Chernyak, Harvard-MIT Division of Health Sciences and Technology; Roberta Brawer, Program in Science, Technology and Society; Dr. Christopher Sawyer-Laucanno, Program in Writing and Humanistic Studies; Dr. Jerome Y. Lettvin, Department of Electrical Engineering and Computer Science; Dr. Kevin Rhoads and Cheryl Butters, School of Engineering. Sixteen MIT undergraduates in the fall, three undergraduates over IAP and six undergraduates in the spring were employed as teaching assistants for recitations, tutorials, and grading.

The Concourse Program was overseen by Robert M. Rose as Director and by Cheryl A. Butters as Program Coordinator.

Robert M. Rose

INDUSTRIAL PERFORMANCE CENTER

The MIT Industrial Performance Center is dedicated to the study of industries in the United States and in other advanced economies. The Center brings together the intellectual resources of the Institute 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 developments 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 and Social Sciences, Science, and Architecture and Planning, the Center today serves as a listening post on industry, monitoring patterns of organizational and technological practice, interpreting them for our partners and sponsors, and feeding our observations and insights back into the core disciplines and educational curricula of the Institute.

HIGHLIGHTS

The Industrial Performance Center received a major grant from a consortium of industrial, trade and government organizations in Hong Kong to conduct a one-year study of the role of industry in the future development of the Hong Kong economy. The project, entitled "Made By Hong Kong", provided an understanding of how a society with a strong manufacturing past can develop new strengths and new activities; how industries operating in the larger China region can utilize the advantages presented by the proximity of a large market, low-cost labor, and access to emergent strengths in advanced technology; and how economic capabilities, employment, and social well-being can be maintained even as many of society's production facilities move outside domestic territory. These are challenges that confront not only Hong Kong over the next decade, but that in some measure are faced by all advanced industrialized countries today. The study was undertaken by a cross-disciplinary team of twenty-three faculty, staff and student researchers drawn from across the Institute. The project leaders were Professors Suzanne Berger and Richard Lester. Other senior researchers included Professors Alice Amsden, Andrew Bernard, Rafael Reif, Charles Sodini, and Daniel Wang and Drs. David Tennenhouse and Victor Zue. The results of the research were presented at two major conferences in Hong Kong during 1997, and were published as a book, *Made By Hong Kong* (Oxford University Press, 1997), which has received wide attention in Hong Kong and elsewhere (and was a best-seller in Hong Kong during the summer of 1997.)

Also during 1996-7, a major grant was received from the German-American Academic Council Foundation to conduct a new study of international changes in industrial research and development. This work, conducted jointly with the Fraunhofer Institute for Systems and Innovation Research (ISI), Karlsruhe, Germany, will examine changing patterns of industrial innovation and the implications for university-industry relations. The project grows out of the IPC Faculty Seminar on the same topic, conducted during 1995-96. The research will be led by Professor Richard Locke (Political Science and Management), Professor Ed Roberts (Management), and Professor Richard Lester (Nuclear Engineering).

New books published by IPC-affiliated faculty during the year included *Teaching the New Basic Skills*, by Richard Murnane and Frank Levy, and *National Diversity and Global Capitalism*, edited by Suzanne Berger and Ronald Dore.

RESEARCH

The Center's research program is organized around four major themes: (1) Technology and the American Worker; (2) Measuring Industrial Performance, (3) New Approaches to Organizational Integration, and (4) Globalization and the Location of Core Productive Functions. Several research projects addressing specific topics under these themes are underway.

Professor Frank Levy is continuing his research on the impact of information technology on the content and productivity of specific occupations and on the demand for skills, education, and training. As part of this research, Levy organized a seminar series on this topic during the academic year which brought several leading practitioners to the Institute.

Professor Richard Lester, Professor Michael Piore and their graduate students are continuing their studies of design and product development. Their main focus is on the development of a new theory of interpretive organization

applicable to product development and more generally to the management of modern business enterprise. Their research is built on an empirical foundations of case studies of new product development in the cellular telephony, apparel, medical device and automobile industries.

Professor Erik Brynjolfsson's studies of the impact of information technology on business practice and productivity have recently focused on the relationship between information technology (IT) and the organizational architecture of firms, and the effect of this relationship on firm productivity. His latest research (carried out in collaboration with IPC Doctoral Fellow Loren Hitt) suggests that greater use of IT is associated with greater decentralization of decision rights, greater investments in human capital, and increased use of subjective incentive systems. He further finds that firms adopting this decentralized work system show higher productivity from their IT investments.

Professor Andrew Bernard has continued his research on the performance of U.S. exporters. In collaboration with Bradford Jensen of the Bureau of the Census, he found that the recent U.S. export boom is primarily attributable to changes in exchange rates and rises in foreign income, while productivity increases in U.S. plants have played a relatively small role. Bernard has also studied the performance of German manufacturing exporters.

As part of his project on technology supply chains, Professor Charles Fine and his students have been comparing the make-buy decisions of similar companies facing similar choices. They find that very different patterns of interdependencies along companies' supply chains result from these decisions. To explain the differences, Fine and his collaborators have proposed a framework that integrates ideas about core competencies, the product development process, systems engineering, product architecture and modularity, and supply chain design.

Professor Richard Locke and his students are studying the rich array of experiments with new practices and organizational forms now underway in a broad range of local and international labor unions. They are analyzing the organizational and institutional factors that promote and hinder innovation in the American labor movement.

OTHER ACTIVITIES

The Center sponsors a Doctoral Fellowship program that provides opportunities for highly qualified doctoral students to pursue independent thesis research in fields related to the Center's mission. Candidates are selected on a competitive basis and are drawn from across the Institute. To date, 16 fellowships have been awarded.

The Center also sponsors a variety of research seminars. During the course of the last year, seminar series have been organized on "Producing in Asia", "Computers and Work", and "Interactive Approaches to Management: The Role of Narrative."

The Center also continues to play a role in helping to develop intellectual connections and research collaborations among the Sloan Foundation's national network of Industry Studies. The Center is responsible for the Sloan Human Resources Network, which was created to support research and to encourage communications among those doing human resources-related research with the Industry Studies. The summer 1996 issue of Industrial Relations contained a symposium of papers on the topic of "What Works at Work?" These papers were authored by participants in the HR Network and are drawn from several Sloan industry projects.

More information about the Industrial Performance Center can be found on the World Wide Web at the following URL: <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 a variety of technologies practiced in different cultures and historical periods. ISP promotes a form of education that seeks to show students the interrelatedness of ideas and processes in the sciences, humanities and social sciences. Hands-on learning is emphasized as a complement to the theoretical work that is a typical component of the first-year curriculum. 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.

Formerly housed administratively in the School of Humanities and Social Sciences, ISP is now under the joint sponsorship of SHSS and the School of Engineering. The program has also reorganized administratively so that students take an increasingly greater responsibility in running the workshops connected to our HASS-D subjects on technologies. We offered a seminar jointly with the Experimental Studies Group (ESG): a student-taught seminar on Robotics, which stresses concepts encountered in 8.01; it includes 'brown bag robotics kits' for each student.

The two semester HASS-D subjects on technologies that form the core of ISP were once again marked by hard work, creativity, and enthusiasm of the students. The primary responsibility for these subjects lies with Peter Dourmashkin and Professor Arthur Steinberg, with Frederica Steinberg coordinating the integrated writing component. To improve students' competency in writing, designing presentations, and working as part of a team to develop an idea, we have added new material to these subjects and modified existing approaches. In fall semester, students worked in small teams to construct an oral history of Building 20 by interviewing and videotaping current and former residents of the building, and researching their contributions by using the MIT Archives. In spring we ran a very successful project on team-constructed business plans for new textile mills in the 19th century Merrimack Valley.

Workshops connected to the humanities subjects were enhanced by the participation of guest presenters, including Toby Bashaw, blacksmith, Debbie Watson, weaver and dyer, and Dr. Ed Franquemont, anthropologist and specialist on Incan weaving.

ISP ran a weekly luncheon for freshmen with guests from the MIT and greater community speaking about their work.

ISP is continuing to develop a strong writing curriculum under the leadership of Ms. Steinberg. This writing program is built around short, developmentally effective writing assignments integrated within ISP's fall and spring HASS-D subjects. At the heart of the program is prompt feedback on outlines, drafts, and final papers from a grading staff, including undergraduates. Students also worked on writing through a variety of activities including journals, peer conferences and brain-storming sessions, and workshops devoted to specific topics.

Besides these HASS-D subjects ISP offered recitations in some of the science and math core subjects, and tutorials for students who request them.

ISP welcomes Renée Hoffman as a new support staff member.

Of the 26 (16 male; 10 female) students enrolling in the fall, 4 were members of underrepresented minority groups. In spring, of the 39 (25 male; 14 female) who enrolled, 4 were members of underrepresented minority groups.

ISP is overseen by Arthur Steinberg, Director, and Debra Aczel, Program Administrator.

Arthur Steinberg

LABORATORY FOR COMPUTER SCIENCE

The MIT Laboratory for Computer Science (LCS) is an interdepartmental laboratory whose principal goal is research in computer science and technology toward a better life for all people.

Founded as Project MAC in 1963, the Laboratory developed one of the world's earliest time-shared computer systems. This early research (1960-1970) on the Compatible Time Sharing System (CTSS) and its successor, Multics laid the foundation for many of today's commonplace software systems and approaches, such as operating systems written in high-level programming languages, virtual memory, tree directories, on-line scheduling algorithms, line and page editors, secure operating systems, concepts and techniques for access control, 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 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.

The Laboratory's current research falls into four principal categories: Information Infrastructure and Distributed Systems; Human Interaction/Intelligent Systems; Computationally Intense Systems; and Theory. The principal goals of these four categories are as follows:

In the areas of *Information Infrastructure and Distributed Systems*, we wish to understand principles and pursue technologies for the architecture and use of highly scaleable information infrastructures. Transactions among such distributed systems will 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. We wish to explore new emerging forces such as groupwork across space and time and automation of computer-to-computer actions. This research is expected 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, which, with the help of its participating companies, helps set the standard for a continuously evolving Web is a significant and major focus of our work in this area.

In the *Human Interaction/Intelligent Systems* 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. On the human-interaction side, the two principal areas of our focus are conversational spoken dialogue systems between people and machines and graphics systems used predominantly for output. On the Intelligent Systems side, we focus on programs that reason about clinical issues and help in clinical decision making and health care.

In the *Computationally Intense Systems* area, we strive to harness the power and economy of numerous processors working on the same task. Research in the area involves the analysis and construction of various parallel hardware architectures, programming languages and operating systems that yield cost-performance improvements of several orders of magnitude relative to single processors. We are also carrying out research on the uses of computationally intense systems in several application areas for the purpose of improving architectures and programs that we develop, based on actual experience and utility.

Taken together, these three thrusts in infrastructure, human interaction/intelligent systems and computationally intense systems 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.

Research highlights during the reporting period are as follows:

The World Wide Web Consortium (W3C): As of this report, 180 organizations have joined this consortium in order to participate in and contribute to the orderly evolution of the World Wide Web (W3). The team currently is very close to its planned size of some 15 full-time equivalents at each site, plus students. We have signed an agreement with Keio University in Japan similar to that with INRIA so that we may have Asian representation and contributions to the evolution of W3. The Consortium's PICS effort for parental control of Internet/Web sites based on third parties' ratings has stimulated the concept of *metadata*, now for possible inclusion in the Web standard. With *metadata*, people and machines will be able to represent and, therefore, write and read characterizations about information such as its quality and veracity and appropriateness for designated purposes.

Spoken Language Systems: Our Spoken Language Systems Group has expanded and strengthened the capabilities of their demonstration systems through continued improvements of human language technologies, including speech recognition/synthesis and language understand/generation. For speech, we now focus our attention almost exclusively on telephone input. At the system level, we continue to address multilingual issues, with particular attention paid to Mandarin and Spanish, and to "display-less" dialogue for human computer interactions. During the past year, we introduced WebGalaxy, a conversational interface that is completely embedded in a web browser. More recently, we have also developed Jupiter, a telephone based weather information service that users can call to obtain on-line weather information via a toll free number.

Multiprocessor Architectures: The group has had a busy year building the StarT family of parallel computers. The group will be completing its flagship StarT-Voyager machine at the end of 1997. StarT-Voyager consists of 32 IBM workstations connected to the Arctic switch fabric designed at the Laboratory. Each workstation will be equipped with a network interface unit (NIU) on its memory bus in an aggressive design intended to provide low-latency and high-bandwidth. The Voyager NIU is programmable, making the machine an ideal platform to study distributed shared memory protocols. The first Arctic routing chips have become operational in the past few months and have been tested using the StarT-JR NIU completed last year. The StarT-JR NIU offers easy access to the Arctic network to any machine with a standard PCI bus, though at lower performance than the StarT-Voyager NIU. Still, the great speed (30 MB/sec) of the StarT-JR NIU relative to existing commercial networking technology has led us to plan its incorporation into the Xolas, Digital, and future Intel clusters at the Laboratory for Computer Science. In addition, the group has also been active in all aspects of parallel software research through the exploration of the implicitly parallel programming languages pH and Id. Two new optimizing compilers, based on novel code-generation techniques, will be released this year and are expected to provide greatly improved execution performance.

Theory of Computation: Hot spots arise in the world wide web (and other distributed systems) when a single item or site becomes extremely popular. The server responsible becomes so heavily loaded that it is unable to respond to all the requests. This can lead to extremely long delays or even crash the unfortunate server. Caching is a scheme that can be used to eliminate hot spots---other lightly loaded servers are given copies of the popular items and serve some of the requests for it, reducing the load faced by the original server. To make caching work, one needs good rules for deciding which caches are going to serve which hot items. This is especially complicated in a domain like the internet, where machines are added and removed with great frequency. We developed a new scheme, *consistent hashing*, that provides the load-balancing benefits of standard hashing but allows for the kind of changing and

incomplete information about global state (e.g., which machines are presently up) that is typical of an environment like the web. Combined with a particular randomized embedding of hierarchies of caches in the network, it lets us give provably good bounds on the load experienced by any cache, and guarantee that no hot spots will arise.

Computational Biology: Professor Berger's virus shell assembly work has led to the ongoing development of an integrated system for the discovery of a new class of antivirals called Capsid Assembly Targeted (CAT) antivirals. CAT antivirals are chemotherapeutic agents targeted directly at the protein/protein interactions required for viral capsid assembly. It is anticipated that CAT antivirals will be highly effective, specific, and robust, while at the same time having a short lead time for discovery. The system for their discovery consists of novel computational tools, as well as novel applications of cutting edge biotechnology. This work was reported in a Genetic Engineering News article. The group has also developed programs for identifying new potential coiled coils in protein sequences. Over the course of the last year, their PairCoil program has been run or downloaded over the Web by more than a thousand different people. Their PairCoil and LearnCoil programs have been useful at identifying coiled coil regions in HIV and other viruses such as influenza and Moloney murine leukemia virus, where the coiled coil is thought to be the mechanism by which the virus binds to the cell membrane during infection. The structures of these viruses have since been solved by Prof. Peter S. Kim's lab, whose work on HIV was reported in many press releases, including the NYT's, ABC News, and Science News.

Software Devices and Systems: Dr. Tennenhouse, leader of the Telemedia, Networks and Systems Group, has gone to DARPA where he will direct the Information Technology Office. His group has been merged with Professor Guttag's group, the Systematic Program Development Group. The combined group, called Software Devices and Systems, headed by Professor Guttag, is already well on its way with the development of Spectrumware -- a totally digital approach to the detection and processing of communication signals, from the antenna that receives them to the final function that they are intended to perform.

In June 1997, *Business Week's* special issue on "The Digital Frontiers" conducted a Delphi Poll that rated research laboratories worldwide. We are proud that LCS was ranked second.

During this reporting period, the Laboratory's Distinguished Lecturer Series included presentations by Dr. Whitfield Diffie, Distinguished Engineer, Sun Microsystems, Inc., Dr. Anita K. Jones, Director, Defense Research and Engineering, DOD, Dr. John Warnock, President and CEO, Adobe Systems, and Professor David R. Cheriton, Stanford University. The Laboratory is organized into 14 research groups, an administrative unit, and a computer service support unit. The Laboratory's membership comprises a total of 459 people, including 79 faculty and research staff, 141 graduate students, 129 undergraduate students, 75 visitors, affiliates, and postdoctoral associates and fellows, and 35 support staff. The academic affiliation of most of the Laboratory's faculty and students is with the Department of Electrical Engineering and Computer Science (EECS).

About 60% of the Laboratory's funding comes from the US Government's 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 hardware systems, consortia for the development and maintenance of standards, such as the World Wide Web, and joint studies on research areas of common concern.

More information about the Laboratory can be found on the World Wide Web 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 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 to the molecular 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 10 faculty from EECS, one Senior Lecturer, 2 Senior Research Engineers, 6 research staff, 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 ME, CE, MS&E and NE are collaborators in many of the laboratory's programs, and there are extensive joint activities with the Microsystems Technology Laboratory (MTL) and the Energy Laboratory. LEES is also an active participant in the Leaders for Manufacturing Program, and the Technology and Policy Program (TPP). During the past year the laboratory has experienced a continued expansion of its automotive related research, demonstrated a 1/5 scale Maglev test facility for high temperature superconductors, and created a consortium on Transmission Provision and Pricing Under Open Access.

AUTOMOTIVE ELECTRONICS AND ELECTRICAL SYSTEMS

Professor John G. Kassakian and Dr. Thomas M. Jahns 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. Four new members were added to the consortium in the past year, bringing the membership to 13. The consortium held four two-day meetings and organized a major industry wide workshop to promote the adoption of 42 volts as a standard for future automotive electrical systems. The laboratory has also engaged in a strategic alliance with Ford to accelerate the adoption of this standard. Under the auspices of the consortium, the multi-attribute trade-off analysis tool MAESTrO has been upgraded to near commercial quality by an outside software developer. Professors James L. Kirtley and Jeffrey H. Lang, Dr. Jahns and graduate student Edward Lovelace have been investigating the designs of high power starter/alternators for future cars. Permanent magnet, induction, switched reluctance, hybrid induction and Lundell machines have been considered. A prototype of the most promising design will be built and tested during the next year.

Under sponsorship from Daimler-Benz, Dr. Jahns and graduate students Khurram Afridi and Isaac Trefz have adapted MAESTrO for application to the electrical systems of trucks and buses. This work has been very favorably received by Daimler-Benz.

With graduate student Deron Jackson, Professor Steven B. Leeb has continued development of a 3 kW prototype of a battery charging system for electric vehicles employing a non-ohmic, magnetically-coupled connector system. A bi-directional version of the charger has been completed that permits both carefully controlled battery charging from the utility, and also controlled discharging of the battery back into the utility. This bi-directional capability is essential for ensuring maximum battery life. Other applications for non-ohmic power transfer are under investigation, including incorporation into marine refrigeration units and hinged, fire-resistant power couplings for doors.

HIGH SPEED AND AUTOMATED TRANSPORTATION SYSTEMS

Professor Richard D. Thornton and graduate students Marc Thompson, Brian Perreault and Scott Macgreggor completed three projects concerned with applying magnetics and computers to automated transportation systems. Mr. Thompson completed his Ph.D. thesis with the design, test and analysis of a 1/5 scale magnetically levitated (Maglev) train test facility suitable for high-temperature superconductors. A new low cost multiple loop guideway was built and tested, and resultant electrodynamic forces were measured at actual Maglev train operating speeds. The results were compared to predictions based on simple circuit models, with close correlation. The test fixture was also used to validate the concept of lift generation at zero velocity by ac excitation of the main magnet coils. In further tests, a novel magnetic active secondary suspension was tested. Results show that it may be possible to actively control ride quality by varying the high temperature superconducting coil currents, removing the requirement for a mechanical suspension for ride control.

Mr. Perreault completed his Ph.D. thesis on position sensing and communication between guided vehicles operating under automatic control. The system allows vehicles to keep accurate track of the position of other vehicles and to communicate messages between vehicles and from a vehicle to a central control. The system does not make use of radio waves and is suitable for use with almost any type of guidance and propulsion system.

Mr. Macgregor completed his M.Eng. thesis on fault tolerant control for automated transportation. He demonstrated a multiprocessor system that can sense when any one processor fails and take corrective action to eliminate any accident that might occur without fault tolerant protection.

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.

MODELING AND CONTROL

Professor Bernard Lesieutre and graduate student James Hockenberry have developed a nonlinear thermostatic load model as part of Professor Lesieutre's ongoing research on power system dynamic load modeling sponsored by the NSF. In previous work the importance of proper load models has been demonstrated, an improved probabilistic aggregate model of a cluster of induction motors was developed, and common lighting and power electronic loads were investigated. The new thermostatic load model captures important characteristics that are lacking in traditional "voltage recovery" and linear system models. Professor Lesieutre has also begun new research in the area of uncertainty analysis in large scale power system simulations.

A great deal of power system practice is dependent on transient simulators, but these are often used uncritically and without insight. Professors Lesieutre and George C. Verghese have initiated work on intelligent simulation aids for power system transient simulators. They are also continuing their studies of new approaches to reduction of large power system dynamic models, with a view to reducing simulation times.

Professor Verghese and graduate student Ben Leong, in collaboration with Dr. Joseph Thottuvellil of Lucent Technologies, have been conducting pioneering studies of the interesting dynamic properties of broadband power networks that are being put into place to power coax/optical fiber communication networks. The loads on these networks are regulated power electronic supplies, which are activated once the voltage across their input exceeds some threshold. The results obtained thus far describe the dynamic and steady-state properties of these nonlinear networks, provide guidance on what choice of threshold voltage will ensure that the network settles into a desirable steady state, and also suggest simple approximate calculations that provide rapid yet accurate numerical results.

Dr. Marija Ilic, in collaboration with Professor Francisco Galiana of McGill University and the Energy Laboratory's Electric Utility Program, has created the Consortium on Transmission Provision and Pricing Under Open Access. The consortium is studying issues related to the operational stability of the regional power grid in the face of the relaxed control over individual generators implied by the deregulation of the electric utility industry.

Professor Lesieutre, Dr. Ilic and Professor Verghese were the organizers and hosts of the North American Power Symposium held at MIT in October 1996. The Symposium included a session on challenges under deregulation and a plenary talk on the major summer blackouts of 1995. It drew world-wide participation and was highly successful.

ADAPTIVE MONITORING OF TRANSFORMERS

Research Engineer Wayne Hagman and graduate students Mary Jane Boyd and Paul Barrett have completed the design for the next generation of software for the MIT Adaptive Transformer Monitoring System, including enhanced intra-system inter-process communication of data information. Mr. Hagman has also trained a number of Boston Edison employees in the use and maintenance of the MIT systems that are monitoring five of Boston Edison's large substation transformers. Ms Boyd has also developed artificial intelligence methods for the integration of spatial and temporal information in the detection of anomalies, and knowledge elicitation and structuring in the context of on-line power apparatus monitoring.

Principal Research Engineer Chathan Cooke has demonstrated, on an energized 500 kV power transformer at Consolidated Edison, a system capable of on-line detection of defects that induce internal partial discharges (PDs) in large power transformers. The system uses advanced time and frequency domain signal processing to identify and locate PD events. A tear-down of the transformer showed excellent correlation between the measured PD signals and actual tracking damage of the internal winding. Dr. Cooke is now making the measurement system robust enough for field application.

Professor Lesieutre and graduate student Reza Olfati-Saber have developed a neural state space model (NSSM) for describing the relations between temperature and measured dissolved gas content in transformer oil. The advantage of the NSSM approach is that the unknown functional form for the components of a traditional nonlinear state space model can be approximated by neural networks and estimated from measured data. The NSSM model should significantly improve the transformer thermal model and facilitate the detection and diagnosis of certain problems, and allow better evaluation of the present condition for purposes of dynamic loading.

The laboratory's efforts to team with an appropriate company to produce and market a transformer monitoring system based on the technology developed in LEES appears to have been successful. It is expected that by August, 1997, an agreement will be in place that both licenses the technology and provides funding for continued research.

NON-INTRUSIVE LOAD MONITORING

Professor Leeb, in collaboration with Professor Leslie K. Norford of the Department of Architecture, and with graduate student Steven R. Shaw, have demonstrated techniques that extend the capabilities of the Nonintrusive Load Monitor (NILM) to the determination of power quality, i.e., current waveform shape, anywhere in a monitored building. Also, diagnostic techniques have been developed that permit the NILM to determine the parameters of models describing important loads, e.g., induction motors, solely from partial electrical measurements made at the utility service entrance. A second patent on the NILM technology will be awarded in 1997. A field portable platform capable of implementing not only the NILM algorithm but also the power quality and diagnostic techniques will be completed this year and tested in on-campus buildings and off-campus manufacturing operations.

ELECTROMECHANICS ELECTRICAL MACHINES

The Novice Design Assistant (NDA), a computer aided tool for designing three-phase induction motors developed by Professor Kirtley and graduate student Ujjwal Sinha, has been enhanced by the development of a technique based on multi-dimensional adaptive regressive splines for adapting the design space for use with an NDA design synthesis. Work is progressing to build the NDA into the production design software of Magnetek, the sponsor of this research.

GEL POLYMER ACTUATORS

Professor Leeb, in collaboration with Professor Toyochi Tanaka of the Center for Materials Science and Engineering, and with graduate students Ahmed Mitwalli, Deron Jackson and Tim Dennison, continue to explore applications of polymer gels as actuators and sensors. Building on last year's demonstration of a thermo-optical gel sensor for metal ion detection, a new multi-sensor apparatus has been constructed that estimates, in real time, the transition temperature at a number of positions in a long gel. This sensor is being used to explore the possibility of identifying the components of a mixture by using the gel as a chromatogram. For example, if the constituents of a given mixture exhibit different mobilities in the gel, the gel could serve as a chromatographic or electrophoretic medium for separating the mix. As the mix separates, different regions of the gel exhibit different phase transition temperatures, which correspond to the local concentrations of the constituents. Optical sensors, placed along the length of the gel to scan the different phase transition temperatures in different regions of the gel, could be used to identify the components of the mix.

Work is also underway to develop new imaging techniques for "soft" materials like gels. Professor Leeb and Mr. Dennison are working to use the Faraday effect to develop tomographic imaging techniques for optically translucent materials with differing Verdet constants. These new imaging technologies might ultimately be used to develop more sophisticated approaches for examining spatial separation in phase transition chromatography experiments.

BIOLOGICAL ELECTROMECHANICS

Professor Martha Gray and her group have made important strides in their work on the use of magnetic resonance (MR) methods for measuring the composition and functional integrity of cartilage. Specifically, they have demonstrated that a method designed to measure the fixed charge density of cartilage corresponds quantitatively to destructive biochemical measures of charge and qualitatively to histological measures. Moreover, they have established that their methods are feasible in a clinical setting with pilot studies revealing information not available with traditional MRI scans. This method offers the potential to monitor cartilage disease progression and therapeutic efficacy with a specificity and sensitivity not previously available.

POWER ELECTRONICS

Professor Kassakian, with graduate students David Perreault and Kenji Sato, have completed the construction and testing of a prototype 6 kW unity power factor rectifier designed using the cellular architecture that they have been studying for several years. A new single-wire, but robust, current sharing and interleaving scheme has also been incorporated in the prototype. This highly reliable, and potentially very economical, power electronic architecture is currently being applied to advanced automotive applications where the cost and reliability of power electronics has been a major obstacle to its penetration of the automotive market.

Professor Verghese, with Dr. Joseph Thottuvellil of Lucent Technologies and David Perreault have developed and tested the first precise criteria for stability of paralleled power converters under active current sharing. These results are already being applied by designers at Lucent and elsewhere.

Professor Verghese in collaboration with Professor Aleksandar Stankovic of Northeastern University, Professor Paolo Mattavelli of the University of Padova, Italy, and graduate students Vahe Caliskan and Chalee Asavathiratham, have continued – with support from the NSF – to demonstrate the efficacy of harmonic averaging methods in constructing frequency-selective dynamic models for power electronic components. These models permit the user to focus on the behavior of interest, while suppressing irrelevant detail. They are well matched to the phasor representations used in power system applications, lead to much faster simulations and more tractable starting points for control design, and are more accurate than those obtained by traditional averaging methods.

Professor Anantha Chandrakasan with graduate students Rajeevan Amirtharajah, Abram Dancy and Vadim Gutnik have developed embedded power techniques for portable electronic systems. They have shown that providing a feedback path from the digital signal processor to the power supply module can reduce the power dissipation of the processor. Rather than designing a feedback system around the power converter to fix the output voltage, it is better to allow the voltage to vary such that the timing constraints are just met at any given temperature and operating conditions. They have also developed a variety of techniques for achieving high efficiency at low voltages and power levels which include delay line based pulse width modulation, low resolution feedback, voltage quantization, etc. Mr. Amirtharajah extended this work to develop a self-power system where the energy required by the electronics is derived from the environment (e.g., motion). Such techniques will be critical for future battery operated wireless sensors. This work was recently reported in a Nikkie Times article in Japan.

HIGH VOLTAGE AND INSULATION RESEARCH

Professor Lesieutre and Professor Markus Zahn, with graduate students Alexander Mamishev and Yanqing Du, have redesigned the MIT-developed three-wavelength dielectrometry sensor to maximize its signal to noise ratio and to minimize cross-coupling effects between wavelengths. They have also conducted experiments to study the diffusion process of moisture between oil and pressboard to better understand and quantify the flow electrification problem in transformers, which can lead to a transformer failure when a cold transformer is energized.

Professor Zahn and graduate student Afsin Üstündag have extended their mathematical formulation that allows reconstruction of an applied electric field from light intensity measurements using electric field induced birefringence (Kerr effect) even when the magnitude and direction of the electric field varies along the light path. Using an “onion-peeling” method it is possible to calculate from light intensity measurements the magnitude and direction of an applied electric field. This methodology is being used to research the effects of charge injection on electrical conduction and breakdown behavior in high field stressed dielectrics. Graduate student Tza-Jing Gung has performed numerous confirming experiments using needle-to-plane electrodes stressed by high voltages.

Dr. Cooke and graduate student Robert Lyons have enhanced their ultrasound method for detecting charges and defects within XLPE polymer power cables. They have increased the resolution of the measurement system and applied it to the detection of localized space-charge phenomena at high applied stresses, and have observed distinct charge processes just prior to the electrical treeing breakdown failure. An improved system to observe charge conditions prior to tree inception is under construction. This will allow direct observation of the details of the micro-processes and to compare the results with theory.

In cooperation with Tokyo Electric Power Company's research laboratory (TEPCO), Dr. Cooke has established an internet link to exchange data from ultrasound charge measurement experiments at TEPCO and MIT. This link allows daily cooperative communication, including audio, video, and file sharing between groups, and direct viewing of the remote experiments. The link is used to compare experimental results and models for charge transport in XLPE polymer power cables.

PERSONNEL CHANGES

Mr. Paul Warren, a longtime Research Engineer in LEES left the laboratory to join the research activities of the Gas Turbine Laboratory. Mrs. Barbara Connolly and Mrs. Kathleen McCue both retired from MIT during the last year.

Dr. Thomas M. Jahns, on a two year sabbatical leave from General Electric's Corporate Research and Development Laboratory, has joined LEES as Senior Lecturer and is working closely with Professor Kassakian. Ms Karin Janson-Strasswimmer and Ms Sara Wolfson have joined the laboratory as Senior Secretaries.

John G. Kassakian

LABORATORY FOR INFORMATION AND DECISION SYSTEMS

The Laboratory for Information and Decision Systems (LIDS) is an interdepartmental research laboratory of the Massachusetts Institute of Technology. Its staff includes faculty members, full-time research scientists, postdoctoral fellows, graduate research assistants, and support personnel. Undergraduate students participate in the research program of the Laboratory through the Undergraduate Research Opportunities Program (UROP). Every year several research scientists from various parts of the world visit the Laboratory to participate in its research programs.

The fundamental 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. The Laboratory is conducting basic theoretical studies in communication, control, and signal processing, and is committed to advancing the state of knowledge in technologically important areas.

As an interdepartmental laboratory, LIDS reports to the Dean of the School of Engineering, Professor Robert A. Brown. The Co-Directors of the Laboratory are Professors Robert G. Gallager, Sanjoy K. Mitter, and John N. Tsitsiklis (Acting Co-Director).

The Center for Intelligent Control Systems, an interuniversity, interdisciplinary research center operated by a consortium of Brown University, Harvard University, and MIT, resides administratively within LIDS.

Twelve faculty members, several research staff members, and approximately 60 graduate students are presently associated with the Laboratory and the Center. Currently, the Laboratory and the Center provide some 25 research assistantships to 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 Advanced Research Projects Agency (ARPA), C.S. Draper Laboratory, Motorola University Partnerships in Research, the National Science Foundation (NSF), the Office of Naval Research (ONR), Siemens AG, Tellabs, Inc., and the University Research Initiative Program (ARO).

NEW RESEARCH INITIATIVES

To complement a recently initiated effort in Automatic Target Recognition useful for synthetic aperture Radar, Prof. Alan Willsky and Dr. Hamid Krim have started a new research initiative in Representation theory for recognition which accounts for physical morphology of target objects. The theoretical effort is paralleled with its direct application on many aspects of their other research. The research effort in this area has continued and significant progress has been made in also applying these results. Professor Willsky, Dr. Krim and their students have indeed had great success in object recognition/identification with Real Radar and Synthetic Aperture Radar data.

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), and communications (dynamic channel allocation). This work is conducted by Professors Dimitri Bertsekas and John Tsitsiklis and their students and has been summarized in their recent prize-winning book, *Neuro-Dynamic Programming*.

CURRENT RESEARCH COMMUNICATIONS

A joint project with Microsystems Technology Laboratory (MTL), supported by ARPA, involves constructing a low power wireless sensor that operates efficiently over a wide range of powers and bit rates, from 1 Mb/s for full-motion video to 1 b/s for temperature sensing. One goal of the project is to characterize how constraints on device technology interact with information theoretic limits to determine the best architecture for low power communication. As an example, for indoor line-of-sight communication, radiated RF power is swamped by the power cost of computation. This work is being carried out by Professor Mitchell Trott and his students in LIDS together with Professors Sodini, Schlecht, Chandrakasan, Lee and their students in MTL.

Modern advances in computation have greatly relaxed the complexity constraints that apply to error-correction codes designed for voice-band modems, cable modems, and satellite channels. This has fueled the demand for powerful coding techniques and design methodologies which closely approach the information-theoretic upper bounds on performance. Professors Mitchell Trott, Amos Lapidoth, and Dr. G. David Forney have begun to develop new methods for constructing and evaluating high-performance codes and decoding methods. Research has also begun on the design of universal codes that perform optimally over a broad class of channels. This work is supported by NSF and Motorola.

Researchers from LIDS, RLE, Lincoln Laboratories, and Digital Equipment Corporation have been collaborating for the last several years in developing a universal, wide area, wide band, all optical network. Current funding for the research is provided by ARPA. The goal of the consortium is to pursue research and development on optical technologies, architecture, and application interfaces required for a scalable national or international hierarchical network including local, metropolitan area, and wide area levels. An operational test bed is now in place and a node has been installed at LIDS. The current research in this area is focused on extending the channel speeds of the current wavelength division multiplexing implementation to 10 Gbps., on constructing a solution based TDM local area network, and on developing the architecture for the wide area level. Professor Robert Gallager, Dr. Steve Finn, and a number of their graduate students are involved in this research.

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. Both wide and local networks, both high speed and low speed networks, and both point-to-point and broadcast channels are of concern. One of the major topics of current interest is how to meet quality of service requirements at the internet layer through the diverse types of services that can be provided by highly heterogeneous underlying networks. The growth of both high speed optical networks and low speed wireless networks is making the problem critical. Another topic is finding the fundamental tradeoffs between fairness (i.e., multiple quality of service guarantees) and efficiency in high latency networks. This work is conducted by Professors Bertsekas, Gallager, Dr. Finn and their students.

Professors Robert Gallager, Sanjoy Mitter, Dimitri Bertsekas, John Tsitsiklis, and Drs. Steve Finn and Hamid Krim have initiated a major project investigating the use of heterogeneous networks, particularly optical networks, in large scale distributed fusion problems. This will provide an important application area for the testbed constructed by the consortium on wide band, all-optical networks. It also presents a challenge to the architectures needed to meet quality of service requirements in large distributed systems operating over internetworks of heterogeneous networks. Finally, it provides a focus for work on routing, congestion control, and image fusion and compression. The work is funded by ARO.

CONTROL

Determining the fundamental limitations and capabilities of identification and adaptive control has become an active area of research carried out by Professors Munther Dahleh, John Tsitsiklis, Sanjoy Mitter, and their students. This newly-initiated research program draws upon areas such as information-based complexity theory and computational learning theory, as well as upon the theory of robust control. It aims at developing a deterministic theory for system identification that can directly deal with finite data. Applications involving non-stationary time series will be considered (e.g., feature extraction from EEG Data).

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 Michael Athans, Munther Dahleh, Alexandre Megretski, Gunter Stein, 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 design control systems that can address general performance objectives for various classes of uncertainty. 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, and automotive control systems.

Professors Munther Dahleh and Alexandre Megretski and his students are working on the development of new methods of nonlinear system analysis, and application of these techniques in various control systems, (flight control, firm control, animation control, hybrid systems, etc.). The work involves a broad spectrum of system-theoretic topics including modelling, identification, stability analysis, and optimization. One important objective is to learn how simplifications necessarily made in nonlinear system modelling affect the validity of nonlinear control design.

Hybrid systems are those containing mixtures of logic and continuous dynamics, e.g., digital computers and subsystems modeled as finite automata, coupled with controllers and plants modeled by differential or difference equations. A mathematical model of such systems, based on interacting collections of dynamical systems has been developed. This model is consistent with the theory of optimal control of hybrid systems developed in our laboratory by Professor Sanjoy K. Mitter in collaboration with Professor Michael Branicky, now at Case Western Reserve University, and Professor Vivek Borkar, a visitor from the Indian Institute of Science. Further, since this model builds on the rich theory of dynamical systems, extensions of that theory have been developed. For example, we have extended Lyapunov's stability theory to hybrid systems by developing a theory of multiple Lyapunov functions. Possible applications include programmable logic controllers and power-switching electronics. These analysis tools were also the basis of a collaboration begun with Professor Branicky and Professor Nancy Lynch of MIT's Laboratory for Computer Science on the formal verification of hybrid systems. LIDS' Professor Dahleh and doctoral candidate Jorge Goncalves have also shown interest in this effort. Finally, Professor Branicky was recently a visitor at the Department of Automatic Control, Lund Institute of Technology, Sweden (DAC), where he created some tools for the simulation of hybrid systems. These tools were developed within existing DAC software (Omola/Omsim) and will be ported to LIDS computers for future simulation/experimentation work. Professor Mitter, in collaboration with Professors Borkar and Chandru, has developed a theory of inference involving logic variables by suitably embedding it in Mathematical Programming.

This is a new application area led by Professor Dahleh and his students. By utilizing feedback, a process for developing material such as semi-conductor films can be controlled to meet accurate specifications with only simplified models of the process. This research is being conducted in collaboration with Prof. Kolodziejski from EECS and local industry.

SIGNAL PROCESSING

Over the last few years, the multiresolution models on trees that Prof. Willsky and researchers at INRIA (France) have developed have received tremendous international attention from the research community. Prof. Willsky, Dr. Krim and their students have successfully applied this framework to dramatically reduce high computational complexity and greatly improve performance in a wide array of problems ranging from remote sensing in oceanography to image segmentation and classification in SAR imaging.

The interest in imaging in general and medical applications in particular has greatly grown over the last few years. Prof. Willsky, Dr. Krim and their students, have used to great advantage the inherent multiscale features in images to progressively retrieve significant cues important for enhancement, identification/classification and ultimately diagnosis. This multiscale framework further provides tremendous computational advantages for image reconstruction, known for its high computational demand. Their work is referenced in numerous journals, and has received international attention for its provision of a novel look at what is considered a very important problem.

PERCEPTUAL SYSTEMS AND MACHINE LEARNING

Problems of speech recognition (speaker-independent), handwritten character recognition (on and off-line), and robust vision system design have turned out to be much more difficult than originally thought, owing to the richness and variability of the data and the resulting complexity of the problem of representation. Professor Sanjoy K. Mitter

and his team have recently worked on two different approaches to compute useful representations. The top-down approach, inspired by the work of Grenander, is based on deformable templates and has been applied to character recognition. The bottom-up or compositional approach emphasizes computational efficiency and has been applied to edge detection. Shared by both approaches is the idea that uncertainties and ambiguities must be represented properly and resolved in the right context. This leads naturally to multi-layered representations where the lower levels contain local and data-driven information and the higher levels contain more global and goal-oriented information. Current research efforts attempt to exploit the synergies of the bottom-up and top-down approaches by using feedback mechanisms. Research has shifted toward this compositional, hierarchical approach for recognition of objects in cluttered scenes.

THEORY AND ALGORITHMS FOR OPTIMIZATION

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 communications networks, control theory, power systems, computer-aided manufacturing, and other areas. Currently, in addition to traditional subjects in nonlinear and dynamic programming, there is emphasis on solution of large scale problems involving network flows as well as in the application of decomposition methods. The thrust is two-fold: first, to find ways to handle the typically huge number of constraints; second, to explore the use of distributed and parallel processing to reduce the computation time needed to solve a problem and to economize on information transfer from remote collection points to a computation center. This gives rise to fundamental issues involving the synchronization of computation and communication that are as yet only partially resolved. Professors Bertsekas and Tsitsiklis and their students perform this work.

INFORMATION TRANSFER AND RETRIEVAL

Research on information transfer and retrieval focuses on making interaction with computer-based information systems easier and more effective for human users. This research is supervised by Mr. Richard S. Marcus. A current project involves the development and testing of an expert computer retrieval assistant that makes searching a quantified science rather than an informal art through proper structuring of, and operations on, verbal descriptions of database objects. These objectives are to be obtained through such semi-automated techniques as : (1) derivation of a conceptual formulation of a user's problem and its translation into an initial search strategy; (2) ranking by estimated relevance of documents retrieved thereby; and (3) analysis of user relevance feedback to estimate number of relevant documents not yet received and reformulation of the search strategy to retrieve those missing nuggets. Experiments with a precursor to the expert system have already demonstrated retrieval effectiveness in terms of relevant documents found, equivalent to that achievable by a human information specialist acting as a search assistant. Partly based on this research, a series of operational and retrieval assistant systems have been developed and a new object-oriented expert system with a graphic user interface is now being tested.

MUSICAL AND IMAGE VARIATION VIA NONLINEAR DYNAMICS AND CHAOS

In prior work (Dabby, Chaos, AIP 1996), a chaos-based technique was designed for generating musical variations of an original work. The variations can be close to the original, mutate almost beyond recognition, as well as achieve degrees of variability in between these two extremes. A virtually infinite set of variations is possible. The goal is to make music that changes from one hearing to the next -- not in random ways -- but rather by musical choice of the composer. Accordingly, the musical score becomes dynamic, not fixed. The technique employs two chaotic trajectories, each corresponding to a different set of initial conditions for the Lorenz system. These trajectories map the pitch sequence of a musical score into a variation based on the pitch events of the original piece. The mapping tempers the sensitive dependence of chaotic trajectories to initial conditions via two mechanisms -- linking and tracking -- to help the variations maintain a tie with the original. At present, the chaotic mapping has been extended to generate rhythmic, as well as pitch, variations. The chaotic mapping can also be used to infuse a given work with the attributes of another, e.g., Bach can metamorphose into Gershwin. The design reflects dynamic system concepts, especially those found in nonlinear and chaotic dynamics, coupled with the rich tradition of Western music theory. That the technique produces variations capable of being analyzed and used for musical means -- despite the highly context-dependent nature of music -- suggests the chaotic mapping might be applicable to other context-dependent sequences of symbols, e.g., symbol sequences from scanned art work. Algorithmic development for extension of the chaotic mapping to image and other applications is underway. Research conducted by Diana Dabby, PhD EECS, MIT, and Visiting Assistant Professor of Music at Middlebury College.

CENTER FOR INTELLIGENT CONTROL SYSTEMS

The Center for Intelligent Control Systems (CICS) combines distinguished faculty from MIT, Harvard University, and Brown University in interdisciplinary research on the foundations of intelligent machines and intelligent control systems. Established in October 1986, CICS is headed by Professor Sanjoy Mitter, Director; Professor Roger Brockett, Harvard University, Associate Director; and Professor Donald McClure, Brown University, Associate Director. The research activities of the Center are loosely grouped in five areas: Signal Processing, Image Analysis, and Vision; Automatic Control; Mathematical Foundations of Machine Intelligence; Distributed Information and Control Systems; and Algorithms and Architectures. A number of outstanding graduate students are appointed Graduate Fellows. The Center also hosts several senior visitors for varying lengths of time each year.

Speakers in the Colloquium and Seminar Series included: Prof. Sanjoy K. Mitter of LIDS, Prof. Roger W. Brockett of Harvard University, Prof. Jayant Shah of Northeastern University, Prof. John Baras of the University of Maryland at College Park, Prof. Sanjeev R. Kulkarni of Princeton University, Prof. Dan Spielman of MIT, Dr. Mats Viberg of Chalmers University of Technology, Sweden, Prof. Bixio Rimoldi of Washington University, St. Louis, Prof. Bernard C. Levy of the University of California, Davis, Prof. Andrea Goldsmith of the California Institute of Technology, Prof. Jeff Shamma of the University of Texas at Austin, Dr. Robert Calderbank of AT&T, Prof. Pravin Varaiya of the University of California, Berkeley, Prof. K.J. Astrom of the Lund Institute of Technology, Sweden, Prof. Ken Zeger of the University of California, San Diego, Prof. Drew Fudenberg of Harvard University, Prof. Sergio Verdu of Princeton University, Prof. Amos Lapidot of LIDS, Dr. Aaron D. Wyner of Lucent Technologies, Dr. Alberto Malinverno of Schlumberger Doll Research, Prof. Mriganka Sur of MIT, Dr. William F. Powers of Ford Motor Company, Prof. Prakash Narayan of the University of Maryland at College Park, Dr. Vincent Chan, MIT Lincoln Lab, Prof. Alexandre Megretski of LIDS, Prof. Petar Kokotovic of the University of California, Santa Barbara, Prof. Christos Papadimitriou of the University of California at Berkeley, and Prof. Vadim Utkin of Ohio State University.

VISITORS TO THE LABORATORY

Visitors to the Laboratory for Information and Decision Systems included: Professor Karl Aström of the Lund Institute of Technology, Sweden; Dr. Vivek Borkar, Professor of Electrical Engineering, Indian Institute of Science; Professor Vijay Chandru of Purdue University, Indiana; Professor Meir Feder, Tel Aviv University, Israel; Dr. James Mills, Tellabs Operations, Indiana; Professor James Modestino, RPI, New York; Professor Bixio Rimoldi, Washington University, St. Louis, Missouri; Dr. Charles Rohrs, Tellabs, Indiana; and Professor Allen Tannenbaum, Electrical Engineering, University of Minnesota.

HIGHLIGHTS

Professors Dimitri Bertsekas and John Tsitsiklis together won the 1997 INFORMS Computer Science Technical Section Prize for their book, *Neuro - Dynamic Programming*, Athena Scientific, 1996.

Dr. G. David Forney, Jr. became a member of the EECS faculty and was named Bernard M. Gordon Adjunct Professor on July 1, 1996. He was awarded the Christopher Columbus International Communication Award in October 1996 in Genoa, Italy, and the Marconi International Fellowship in January 1997 in New Delhi, India. Professor Robert G. Gallager delivered the following Keynote talks:

- "Research on Global, Integrated Service, Networking," Informs Applied Probability Conference, Cambridge, July 1, 1997.
- "The Integration of Wireless Communication with High Speed Integrated Networks," International Conference on Network Protocols, Columbus OH. Oct. 30, 1996.
- "Wireless Communication in an Age of Global Integrated Services," ICUCP, Cambridge, MA Sept 30, 1996.
- "The Use of Information Theory in Wireless Networks," Multiaccess, Mobility, Teletraffic for Personal Communications Conference, Paris, France, May 1996.

Dr. Hamid Krim delivered the invited talks, "Two Decades of Array Signal Processing: The Parametric Approach," and "Nonlinear Multiscale Signal Analysis" at the International Meeting of Signals and Systems, Monterey, CA.

Professor Sanjoy K. Mitter delivered an invited lecture entitled, "The Embedding of Logic in Mathematical Programming" (joint work with V. Borkar and V. Chandru) at the Hybrid Systems IV Conference, Ithaca, New York, October 12-14, 1996. He will give the Plenary Lecture at the Fifth IEEE Mediterranean Conference on Control and Systems, Paphos, Cyprus, July 21-23, 1997.

Professor Alan Willsky will give the keynote address at the Wavelets and Applications Conference during the SPIE Symposium, July-August 1997, in San Diego.

Dr. Diana Dabby is an Invited Speaker for the Fourth Experimental Chaos Conference sponsored by the ONR (August 1997). She was one of six selected nationwide for the Tufts University Multicultural Teaching Fellows Program, where she taught Nonlinear Dynamics and Chaos in the EECS Department. She won a national search conducted by Middlebury College and will teach the Advanced Composition courses in the Music Department next year with a focus on musical variation.

More information about this Laboratory can be found on the World Wide Web at the following URL: <http://donald-duck.mit.edu/lids/>

Robert G. Gallager, Sanjoy K. Mitter

LABORATORY FOR MANUFACTURING AND PRODUCTIVITY

The Laboratory for Manufacturing and Productivity (LMP) is an interdepartmental laboratory in the School of Engineering directed by Prof. Timothy G. Gutowski (Mechanical Engineering). It was established in 1977 to conduct engineering research in manufacturing and to develop the fundamentals of manufacturing science. The primary research focus is on design, analysis, and control of manufacturing processes and systems.

The mission of the Laboratory for Manufacturing and Productivity is to be a leader in the development and application of manufacturing technology to improve the manufacturing enterprise. The key intellectual components of this mission are developed through a coordinated program of teaching and research in the following areas: the development of new process technology; the integration of process knowledge into product design; the integration of the process into manufacturing system design and operation.

The outputs of the laboratory are engineering leaders for industry and academia, as well as new technologies, methodologies and knowledge for the improvement of the manufacturing enterprise.

The faculty of the LMP work closely with industry, primarily through industrial consortia and projects. These include the Production System Design Program, the Precision Engineering Group, the 3-D Printing Consortium, the Reconfigurable Tooling Program, the Droplet-Based Manufacturing Consortium, the Continuous Casting Monitoring Program, the Tribology Program, the Microcellular Plastics Program, the Composites Manufacturing Program, the Leaders for Manufacturing Program (Research Group 5 -- Design and Operation of Manufacturing Systems), and the Lean Aircraft Initiative. There are various projects with individual companies. A significant portion of the lab's research is funded by the U.S. Government (DOD, NSF, NASA, DOE), often with an industrial consortium.

RESEARCH FUNDING

The Laboratory for Manufacturing and Productivity enjoyed a very good year with a research volume of \$3.4 M. This constitutes our second best year, but down 15% from last year. A few projects contributed disproportionately to this volume. These included the work of Professor Ely Sachs (3D Printing), Professor David Cochran (Production Systems Design), Professor David Trumper (Precision Engineering), and Professor David Hardt (Reconfigurable Tooling).

AWARDS, HONORS, AND SIGNIFICANT PUBLICATIONS

The research efforts of the LMP faculty have again been recognized nationally. This year Professor Alex Slocum won four prestigious R&D 100 Awards! This is also the third year in a row that he has won this award. The R&D 100 award, is given by R & D Magazine for the 100 most technologically significant products developed for the year. This year four awards were bestowed upon Slocum. They are; 1) "TurboTool Ultra-High Speed Spindle, 2) "Machining Variation Analysis", 3)"ShieldBeam Contactor" and 4) "Kinematic Docking System". Last year he received the award for his "Self Compensating Hydrostatic Bearings". The year before that the faculty of the LMP won two of these awards. These were given to Professor Alex Slocum for his "Replicated Internal Shear Damper" and to Professor Emanuel Sachs for his invention of the Three-Dimensional Printing Process.

Dr. Stanley B. Gershwin became a Fellow of the IEEE For "pioneering work and leadership in the development and implementation of systems and control approach to manufacturing." He also shared Honorable Mention in the INFORMS (Institute for Operations Research and the Management Sciences) Edelman Award Competition for Management Science Achievement.

This year Professor Timothy Gutowski published a book entitled "Advanced Composites Manufacturing" with John Wiley.

Again this year one of our students, Nathan Kane, won the highly esteemed Lemelson Prize for invention. Last year the award was won by David Levy, also a student in the LMP. Both students work with Professor Alex Slocum.

RESEARCH AND EDUCATION HIGHLIGHTS

In the past year several significant new and/or continuing research programs were funded, and several new educational initiatives were started:

Professor David Cochran has successfully launched a significant new program in "Production System Design". This program has captured important new funding from industry, including major awards from Ford. In addition Professor Cochran initiated two new courses in production system design at both the undergraduate and the graduate level, 2.812 and 2.82

Professor Sanjay Sarma has obtained significant new funding from NSF in two important areas; Computer Integrated Manufacturing, and Reference-Free Part Encapsulation. He is also developing a new undergraduate subject (2.31) which integrates F.E.M. and C.A.D.

Professor David Trumper has received several new grants and continued funding in important areas of precision engineering. These include; Magnetic Levitation Stage for Electron Beam Lithography, Magnetic Suspension Control of Precision Motion, Diamond Turning, and Noncontact Processing of Fibers, Beams, Webs and Plates,

Professor Ely Sachs has started several new efforts related to 3D Printing and solid free form fabrication including; Design Automation, Low-Cost, High Performance Tooling by 3D Printing, Structural Materials by 3d Printing, and Three-Dimensional Geometry Generation by 3D Printing.

Professor David Hardt has received continued support for his program on Reconfigurable Tooling for Rapid Response Forming of Aerospace Structures.

Professor Alex Slocum has received continued support from the U.S. Naval Research Lab to study Lean and Agile Precision Machining, in addition he has significant support in various areas of Precision Machine Design.

Professor Jung-Hoon Chun continues to develop his new program on Continuous Casting Monitoring; (this is based on a new gamma ray attenuation technique), and he has received new awards and continued support in the area of his uniform metal droplet process.

Professor Nam Suh has received continued industrial support in the area of microcellular plastics.

Dr. Nanaji Saka has received continued NSF funding in the area of Laser Raman Microprobe Spectroscopy.

Dr. Stanley Gershwin has received continued support in the area of design and operation of manufacturing systems and he has received a significant new award in the area of Wafer Fab Operations: Modeling, Analysis, and Design (funded jointly by NSF and the Semiconductor Research Corporation).

Professor Timothy Gutowski has received continued support in the area of Advanced Composites Forming from NSF and Boeing. He has also received new support in the area software development for cost modeling. Professor Gutowski received two patents this year for innovations on the double diaphragm forming process.

In addition to several machines which we have recently acquired through the efforts of our faculty (Coordinate Measuring Machine, Water Jet Cutting Machine, Bridgeport CNC/ Manual Lathe, Thermoforming Machine, Teleconferencing Station, state-of-the-art Eight Axis Hexel Hexapod Milling Machine) we have also received a new 3-axis CNC/manual Milling Machine from the Bridgeport Milling Machine Company this year.

Timothy G. Gutowski, Stanley B. Gershwin

MATERIALS PROCESSING CENTER

The mission of the Materials Processing Center (MPC) is to provide an environment where students and professionals from industry, government, and academia collaborate to identify and address pivotal multidisciplinary issues in materials processing and manufacturing in a way that

- creates new knowledge,
- produces knowledgeable people, and
- promotes exchange of information in the service of our nation in the context of a global community.

The Materials Processing Center is an interdisciplinary center within MIT's School of Engineering created in response to a recognized national need to improve the materials processing knowledge base and streamline the process of translating materials research results into industrial innovations and applications. Center research covers a broad range of materials and processes and focuses on six basic industrial sectors:

- biomaterials
- primary materials
- structural materials
- electronics
- transportation, and
- energy.

Our metric for the value of this research is its impact on commercial and defense applications.

Because of the interdisciplinary nature of the field of materials processing, faculty and research staff affiliated with the Center come from a range of fields beyond the traditional materials science and engineering group. Significant contributions are being made by specialists in chemical engineering, electrical engineering, mechanical engineering, physics, aeronautical and astronautical engineering, civil and environmental engineering, chemistry, nuclear engineering, and ocean engineering. Center research involves approximately 150 faculty, research staff, visiting scientists, and graduate and undergraduate students.

The MPC builds upon MIT's history of close ties with industry. We have a 40-member Industrial Collegium of domestic and international companies which provides a window on the state-of-the-art in materials research and development at MIT, and provides an outlet for our research results to industry. In this way, the Collegium strengthens the link between university research and industrial innovation. Part of our strategy is to leverage core federal research funding into expanded industrial collaborations. MPC Industrial support currently stands at 45% of our total budget.

HIGHLIGHTS

CENTER INITIATIVES

The MPC initiates programs to enhance the intellectual vitality of the materials processing community at MIT. By measuring the value of these initiatives in terms of the intellectual core they create, we hope to define our community strengths, collaborate in new and creative ways, and pursue the most meaningful research. In 1997 we continued our series of Vision Workshops, designed to explore issues and generate priorities for emerging fields of materials-related research. The second Vision Workshop focused on optoelectronics, specifically "High Dielectric Contrast Structures for Microphotonics". Participants included representatives from academia, industry and federal agencies. The previous workshop addressed "Automotive Processing and Manufacturing Needs."

The MPC sponsors three research funding initiatives: (1) the MPC Visiting Scholar Program, (2) the MPC Young Faculty Seed Program, and (3) the MPC Research Initiative Seed Program. The 1997 MPC Visiting Scholar is Dr. Venkataraman Swaminathan of Lucent Technologies, Inc. in North Andover, MA, who is working with Prof. Kimerling in the area of microelectronics. Prof. Caroline Ross received an MPC Young Faculty Seed award, to create an interdisciplinary team (including Mechanical Engineering, the Microelectronics Technology Laboratory, and the MPC), and assemble industrial support for research on the viability of very high density, "patterned"

magnetic media. The MPC also provided seed funding to the faculty leaders of each of our six basic industrial sectors to facilitate core intellectual, development, and research program initiatives.

The MPC has expanded a number of its information distribution services to include the MPC Short Course Library. This listing of short technical seminars led by MIT faculty and senior research staff offers MIT's industrial partners a concise and focused guide to the expertise of MIT's materials community, spanning several School of Engineering departments. Over the past year, the MPC has maintained a materials subject-related scan of the *Commerce Business Daily*, which is available electronically through MIT's Office of Sponsored Programs. Since its inception last summer, this wholly electronic service has alerted our faculty to important federal research funding opportunities.

Other highlights from the past year include nearly \$2.5M in new industrial research support initiated by the MPC in FY97, as well as an additional two new members to the MPC Industry Collegium.

RESEARCH

Research highlights from the past year are too numerous to report in detail here. A sampling of some of the important breakthroughs achieved by our faculty, research staff, and students follows.

- Dr. Robert C. O'Handley's group, working with a Finnish consortium, reported the first measurements of a giant, magnetic field-controlled strain in the magnetic shape-memory material, Ni₂MnGa. The strain, nearly 0.2%, is greater than that achieved in the piezoelectric transducer PZT or the magnetorestrictive transducer Terfenol-D. This discovery has sparked interest among groups seeking to fabricate smart materials, direct drive motors, and a variety of active noise and vibration damping devices.
- Prof. Paul Laibinis' research group has developed a robust, molecular coating for glasses and metal oxide that resists protein adsorption and retains its properties after autoclave procedures. His group also developed a solution-phase, room temperature method for forming covalently attached, nanometer-thick organic films on porous and crystalline silicon that survive treatment with HF.
- Prof. Lionel Kimerling's group, in collaboration with Profs. Erich Ippen, John Joannopoulos, and Hank Smith, has fabricated and tested a single-mode photonic bandgap (PBG) device with a resonant wavelength at close to 1.5 microns and with submicron structural dimensions. The device was made using high dielectric contrast Si/SiO₂. This is the first device of its kind, demonstrating the capability for direct integration of optical and electronic technologies, as well as the potential for a hundredfold-plus increase in signal processing speed.
- Prof. Eugene Fitzgerald's group has made advances in heteroepitaxy which have allowed the fabrication of lattice-mismatched, relaxed GeSi layers on Si with very few dislocations penetrating the upper layers. This larger GeSi lattice can be subsequently used for the lattice-matched growth of III-V materials like InGaP and GaAs. The ultimate goal is the co-habitation of III-V electronic and optoelectronic devices and Si integrated circuitry, allowing functionality and cost improvements in data storage, high quality printing, microwave communications systems, and high speed processing systems.
- Prof. Yet-Ming Chiang's research group has synthesized several new oxide compositions for higher performance lithium ion battery electrodes. They have also developed high thermal conductivity, high electrical resistivity SiC by liquid phase reactive-infiltration, which is of interest for structural and electronic packaging applications.
- Prof. Jackie Ying was recognized by the American Chemical Society with the Award in Solid State Chemistry this year for her research on synthesis and catalytic properties of nanocrystalline non-stoichiometric catalysts, derivation of a novel class of transition metal oxide molecular sieves, and structure and properties of layered transition metal molybdates. She was appointed to the editorial boards of *Nanostructured Materials* and *Journal of Electroceramics* during the last year. Prof. Ying's research is interdisciplinary in nature, with a theme in synthesis of advanced inorganic materials through nanostructure processing for catalytic, membrane and ceramic applications.

-
- Prof. Clifton Fonstad's research group has continued its work on the Epitaxy-on-Electronics (EoE) monolithic optoelectronic integrated circuit (OEIC) process, and has successfully given the research user community access to this unique technology through the OPTOCHIP Project, the first foundry offering of OEIC's monolithically integrating emitters, detectors, and VLSI electronics.
 - Prof. Ioannis Yannas' invention, known as "MIT artificial skin" and currently manufactured under the name Integra, was approved by the FDA for use in treatment of burn patients by dermal regeneration. It is the first product which induces regeneration of an organ.
 - Prof. Ned Thomas' group is pioneering the use of CdSe-loaded block copolymers for 3D photonic bandgap materials. Recent work on roll casting for anisotropic polymers was awarded a US patent (Albalak, R.J. and E.L. Thomas, Method for Preparing Oriented Polymer Structures, US Air Force Invention No. 21,163, US Patent No. 5,622,668 (1997)).
 - Prof. Harry Tuller's research group has continued its work on developing compatible electrode/solid electrolyte systems for high temperature fuel cells, and investigating electrical activity at grain boundaries in semiconducting oxides. The new Journal of Electroceramics with Prof. Tuller as Editor-in-Chief has been launched with the first issue published in April. Prof. Tuller was awarded the von Humboldt award and began collaborative research with colleagues at the Max Planck Institute on Solid State Research in Stuttgart, Germany.
 - Dr. David Paul, in collaboration with the Magnetic Recording Center group of the University of California, San Diego, has investigated the dynamics of the magnetization process in very thin films. The insight obtained should prove useful in the magnetic recording process and other applications. The work has been accepted for publication in the Journal of Applied Physics under the title "Magnetization Distribution in Thin Films with Perpendicular Surface Anisotropy".

NEW INDUSTRIAL PROJECTS

While the scientific foundation of the materials processing community at MIT has been established with federal research support, our future success will be measured by our ability to leverage this knowledge base into industrially relevant applications. Our 40-member Industry Collegium provides the MPC faculty and senior research staff with the necessary gateway to industry. The staff of the MPC works closely with both our Industry Collegium and Industrial Advisory Board members to understand their needs and match these with the expertise of our faculty. During the past year, these activities were directly responsible for the addition of nearly \$2.5 million in industrial research support from a total of 18 individual companies and federally funded industrial collaborations. This includes:

- The DataCity Center Consortium (including Tekes, Valmet, ABB-Finland and AdaptaMat), has approved Phase II support for Dr. Robert O'Handley's development of magnetic shape-memory materials such as Ni_2MnGa . This effort has also led to participation in a major DARPA-funded program led by Boeing which involves the development of innovative smart materials and actuators.
- Profs. John Joannopoulos and Lionel Kimerling have assembled an interdisciplinary team of physicists, materials engineers and electrical engineers, and have won a major DARPA program in "Photonic Crystal HIDE (Highly-Controlled Infrared Dielectric Emissivity) Materials Engineering" with the collaboration of PPG, Lockheed Martin-Sanders, ARO's Fort Monmouth and Wright-Patterson Air Force Base's Wright Laboratories.
- Prof. Chris Scott has initiated a project at Bayer's polymer division in Springfield, MA, to develop a predictive process model for ABS thermoforming. This proprietary project is conducted via our Materials Processing and Manufacturing Institute (MPMI), which accommodates fully confidential research collaboration.
- Prof. Harry Tuller, Director of MIT's Crystal Physics and Electroceramics Laboratory, has teamed up with Ford Research Laboratory as part of an NSF-sponsored "Grant Opportunities for Academic Liaison with Industry" program to explore and develop versatile multi-component chemical sensors.

NEW INDUSTRIAL INITIATIVES

The MPC provides an active industrial outreach function for the broad, interdepartmental materials community at MIT, using the Industry Collegium to expand our relationships with industry and capitalize on the link between university research and industrial innovation. Our success is reflected by increased industrial research volume in the face of increasing academic and industrial competition for shrinking federal research support. Given that research represents 75% of graduate education, the health of our academic community is dependent upon our ability to work effectively to serve the needs of industry. Downsized U.S. companies are increasingly dependent upon out-sourced solutions to current problems and are actively seeking future growth opportunities via longer term exploration of new products, processes, and directions. Our programmatic trend is to reach directly into industrial operating units where timely solutions are needed and ideas become commercial innovations.

The primary challenge to successful collaboration with industry is in simply getting to know each other's needs and capabilities. With this in mind, we undertook a direct liaison experiment with PPG Industries, Inc., designed to give PPG a clear perspective on the materials community at MIT, along with its capabilities and interests. Dr. Ernest Lawton, a senior research and product development professional with PPG Industries, joined us on campus for the '97 Spring term to explore the depth and breadth of our research efforts, how we conduct research and interact with industrial sponsors, what might be of specific interest to PPG, and how we might collaborate. He had broad access to faculty and students, weekly research group meetings, seminars, numerous opportunities for private discussions, and identified over 20 areas of interest. After coordinating several on-campus visits with his colleagues, Dr. Lawton has helped PPG select three initial priority projects they wish to pursue. We deem this "experiment" to have been a success, and will hopefully repeat it with other companies.

A reciprocal initiative has begun with Corning, Inc., which asked the MPC to provide a range of complementary expertise in support of its core business and technology functions. Specifically, the MPC has been asked to respond to a set of high-priority materials processing issues in three divisions, with excellent results to-date. We hope to expand this collaborative approach into additional industrial partnerships.

Internally, we are structured to focus on establishing specific research program areas based on strong external industrial partnerships. Some of these initiatives are described above. It should also be noted that this approach continues to expand our direct interaction with other MIT labs, centers, and departments including LEES, RLE, MTL, the OR Center, LFM, the Manufacturing Institute, TELAC, and the Chemical Engineering, Electrical Engineering, and Physics Departments.

Our overall research objective is to add at least an additional \$2M in industrial support in FY97. This target is clearly obtainable with currently identified industrial partnership opportunities.

ACADEMIC INITIATIVES

The Materials Processing and Manufacturing Institute, launched in partnership with the Department of Materials Science and Engineering, had a total of six students enrolled in the Program for FY97. The projects are being conducted at:

- Allegheny-Ludlum Corporation
- Lucent Technologies, Inc.
- Norsk Hydro Aluminum, and
- Lord Corporation.

This program provides both MIT faculty and students with the opportunity to participate in high priority, proprietary industrial-site projects. Students receive the combined benefits of an MIT academic experience and industrial research practice. This program provides us with the additional opportunity to have significant impact in the real world while educating the faculty-student teams to this goal.

The MPC continues its Summer Research Internship with the Center for Materials Science and Engineering. This 15th class includes eight undergraduates, seven from other universities. The program provides the faculty with much needed seed support for exploratory research projects and continues to meet its goal of providing undergraduates with an array of multidisciplinary research opportunities in materials.

CONCLUSIONS

MPC is one of few, and by far the largest, university research centers with a materials processing emphasis. Our Collegium represents the strongest industry research interface at MIT. The MPC is ideally positioned to take advantage of the national shift in emphasis to engineering practice and out-sourced research and development. We have restructured internally to identify Research Program Areas and externally with stronger industrial partnerships. We are successful if we

- maintain a strong, dedicated Industry Collegium
- motivate faculty and students to address pivotal issues in materials processing and manufacturing
- involve women and minority faculty and students, and
- continue to increase the research throughput of the Center in the next year.

More information about the Materials Processing Center can be found on the World Wide Web at the following URL: <http://web.mit.edu/mpc/www/>.

Lionel C. Kimerling

MICROSYSTEMS TECHNOLOGY LABORATORIES

The Microsystems Technology Laboratories (MTL) are organized to provide facilities and a working environment to support undergraduate and graduate education through teaching and research in the area of microsystems technology.

The MTL carries out graduate research activities in the fabrication and study of small (i.e., micron, submicron, and nanometer) structures and their use for the implementation of interesting integrated systems from X-ray lenses to VLSI circuits to micro-gas turbine engines. The expanding and dynamic research program covers solid state devices, integrated circuits and systems, materials for electronic applications, novel process technologies, MicroElectroMechanical Devices, and computer-aided fabrication. The MTL houses three clean room facilities (the Integrated Circuits Laboratory - ICL, the Technology Research Laboratory - TRL, and the NanoStructures Laboratory - NSL), and associated non-clean laboratory space (the Research Group Laboratories - RGL), and the Computational and Communication Network facility. The centerpiece facility of the MTL is the Integrated Circuits Laboratory, a state-of-the-art class-10 clean lab with full capabilities for modern IC fabrication. The lab is operated by a full time technical staff and graduate students. The facilities of the MTL are also utilized for the laboratory component of the undergraduate microelectronics processing course (6.152J).

Personnel involved in ongoing research activities at the MTL include over 50 Faculty, 10 Senior Research Staff, 240 Graduate Students, 120 Undergraduate Students, 17 Post-doctoral Fellows, 16 Visiting Scientists, 28 Research Affiliates, 26 Technical Support Staff, and 15 Administrative and Support Staff. These faculty, students and staff represent affiliations including the Departments of Aeronautics and Astronautics, Brain and Cognitive Sciences, Civil Engineering, Chemistry, Chemical Engineering, Electrical Engineering and Computer Science, Materials Science and Engineering, Mechanical Engineering, and Physics; the Center for Materials Science and Engineering, the Center for Space Research, the Gas Turbine Laboratory, the Laboratory for Electromagnetic and Electronic Systems, the Laboratory for Information and Decision Systems, the Laboratory for Computer Science, the Research Laboratory of Electronics, the Sloan School and the Turbulence Research Laboratory. The facilities of the MTL are also open to external users under the Outreach Program (government and academia), and through several industrial programs. Current external users of the MTL include Analog Devices, Digital Semiconductor, Motorola Corp., Hewlett-Packard, Polaroid Corporation, Hitachi, Sharp Corporation, Sony Corporation, Institute for Advanced Engineering, Boston University, Case Western Reserve University, Dartmouth College, Harvard University, Johns Hopkins University, Kanazawa University, Northeastern University, Princeton University, the Smithsonian Astrophysical Observatory, Tufts University, the Shriners Burn Institute, University of Utah, Princeton University, the University of Utah, University of Tokyo, and the Universidad Politecnica de Catalunya. During the 1996-1997 academic year, 16 Ph.D., 20 S. M. and 11 M. Eng. degrees were awarded in conjunction with research activities whose primary area of focus was microfabrication and which were strongly coupled to the facilities of the MTL.

Research in the MTL may be grouped into three major interdisciplinary, interactive research themes: Microsystems, Nanoscale Technology/Devices, and Manufacturing, and further divided into the following ten categories:

Integrated Circuits and Systems include analog and digital integrated circuit (IC) design as well as advanced process development for "mixed analog/digital signal" IC applications.

Microelectromechanical Devices include technologies for micromachining, design of microsensors and microactuators, and the application of these devices to physical and chemical measurements.

Electronic Devices include research on novel devices operating in the semi-classical regime.

Quantum-Effect Devices include novel device structures designed specifically to study and explore quantum mechanical effects arising from carrier interactions with features of sub-100 nm dimensions.

Submicron and Nanometer Structures include some "nanofabrication" projects that are not directly related to electronic devices. The NanoStructures Laboratory develops techniques for the fabrication of surface structures with feature sizes in the range of nanometers to micrometers, and uses these structures in a variety of research projects.

Modeling and Simulation covers the use of numerical techniques that solve complex problems of carrier transport and device operations as well as physical problems that arise during materials and device processing.

Fabrication Technology covers a broad area of processing and device fabrication with two main themes: novel processes for integrated circuit and device fabrication in silicon and compound semiconductors, and fundamentals underlying materials processing effects.

Manufacturing includes computer-based modeling and simulation of fabrication processes and execution in a realistic fabrication environment; work flow scheduling; process equipment modeling and process control; and microstructure/mechanical property simulation.

Materials, with the common theme of growth and characterization of thin films for electronic applications, include research of novel silicon and silicon-germanium epitaxy, the formation of heterostructures in compound semiconductors, polyimides in microelectronics, and the study and control of the crystalline structure of very thin films.

Optoelectronics covers a variety of novel structures such as laser diodes, quantum well structures, and distributed-feedback lasers, both in Si and in compound semiconductors.

The MTL facilities are supported in part by members of the MIT Microsystems Industrial Group (MIG), whose current members include: Analog Devices, Inc.; Applied Materials, Inc.; Advanced Micro Devices; Digital Semiconductor; Ford Microelectronics, Inc.; General Motors Corporation/Delco Electronics/Hughes Electronics; Hewlett-Packard Company; IBM; Intel Corporation; Lucent Technologies; Motorola, Inc.; Polaroid Corporation; Rockwell International; and Texas Instruments, as well as members of the Microsystems Affiliates Program whose members are Kokusai/BTI Corporation and Sony Corporation.

Outreach activities carried out by the MTL include a weekly VLSI Seminar Series, MTL Memo Series, and the MTL Bulletin. The MTL also publishes a comprehensive Annual Report.

More information about the Microsystems Technology Laboratories can be found on the World Wide Web at the following URL: <http://www-mtl.mit.edu/>

Rafael Reif

PROGRAM FOR ENVIRONMENTAL ENGINEERING EDUCATION AND RESEARCH

The Program for Environmental Engineering Education and Research (PEEER) has now completed its sixth and last year of operation in its present form. The Program has functioned as a virtual center with the mission of coordinating and focusing research and education on the intersection between technology and sustainable development. Centered mainly in the School of Engineering, PEEER has involved faculty and research staff members and students from all of the other schools at MIT in examining a wide range of technology-related environmental problems, at all levels from local concerns to issues of international concern and transboundary effects. The objective of the program has been to establish multidisciplinary research efforts where none now exist and to strengthen existing efforts. This basic mission will not change in the future. The ideas and resulting educational, research and outreach activities of PEEER has set the framework for many new environmental interdisciplinary initiatives at MIT: including the MIT/Swiss Federal Institutions of Technology, University of Tokyo Alliance for Global Sustainability, The Management of the Future Uses of Chlorine Project, The Consortium on Environmental Challenges and the Martin Sustainability Fellows. In this process, PEEER has become spread throughout the Institute from its strong base in Engineering. In recognition of this, it will now become Program for Environmental Education and Research PEER. Further, so many new cross MIT environmental initiatives have grown up that a new Institute wide Center for Environmental Initiatives has also been formed to organize all these activities. This new center is described below. The new PEER program will be part of the Center for Environmental Initiatives. Professor David Marks of Civil and Environmental Engineering has become head of the CEI and Professor Jeffrey Steinfeld of the Department of Chemistry will take over as new head of PEER. He will be joined by a co head from Engineering, Dr. John Ehrenfeld of the Technology, Business and Environment Program and a co head from the Social Sciences and Planning, Professor Vicki Norberg Bohm of the Department of Urban Studies and Planning. The PEER program will continue its focus as coordinator and facilitator of MIT's internal environmental focus as well as an incubator for new research and international outreach. It will continue its role of building literacy about the environment throughout the MIT community, helping to encourage and coordinate subjects and educational programs and working to make sure that MIT's "house" is in order. The MIT units most active in PEEER activities who will continue in the new PEER program are:

MIT Energy Laboratory

Professor Jefferson Tester, Chemical Engineering

Center for Technology, Policy and Industrial Development (CTPID)

Professor Daniel Roos, Civil and Environmental Engineering

Professor Nicholas A. Ashford, School of Engineering

Program in Business, Technology and the Environment

Dr. John Ehrenfeld, Chemical Engineering and CTPID

MIT/EPA Center for Airborne Toxins

Professor Jack Howard, Chemical Engineering

MIT/EPA Center for Environmental Remediation

Professor Dennis McLaughlin, Civil and Environmental Engineering

Materials Systems Laboratory

Professor Joel Clark, Materials Science and Engineering

Ralph M. Parsons Laboratory of the Department of Civil and Environmental Engineering

Professor Harold Hemond, Civil and Environmental Engineering

Professor Philip A. Gschwend, Civil and Environmental Engineering

Department of Urban Studies and Planning

Professor Larry Susskind

Professor Lawrence Bacow

Professor Vicki Norberg-Bohm

Department of Aeronautics and Astronautics

Professor Ian Waitz

Department of Civil and Environmental Engineering

Professor Rafael Bras

Department of Chemistry

Professor Jeffrey I. Steinfeld
Department of Nuclear Engineering
Professor George Apostalakis
Professor Michael Golay,
Department of Chemical Engineering
Professor Gregory McRae
Department of Materials Science and Engineering
Professor Donald Sadoway
Department of Ocean Engineering
Professor Alan Brown
Professor Judith Kildow
Department of Electrical Engineering and Computer Science
Professor Rafael Reif
Department of Mechanical Engineering
Professor David Wallace
Division of Toxicology
Professor Stephen Tannenbaum

RESEARCH IN ENVIRONMENTAL ENGINEERING

This year, the PEEER research agenda has been focused on expanding its established long-term goals. The program has pursued work in the four areas of:

- industrial ecology, life cycle analysis, clean technology, green design, and waste minimization;
- defining, measuring, monitoring, and modeling impacts of pollutants on environmental sustainability;
- waste management and environmental remediation; and
- incorporating the best possible science and technology into environmental decision making.

A large volume of research in traditional disciplines is underway at MIT in the area of environmental sciences, technology, and engineering. This research, and its educational components, have kept the Institute in the forefront of international research into environmentally relevant science and technology.

The PEEER perspective represents a new phase of environmental study at MIT, both internally and in international leadership. The Program is designed to stimulate and support inter-disciplinary activities especially in areas of newly evolving research, such as industrial ecology and the influence of science and technology on environmental policy. These activities build on MIT's strong disciplinary base in fields fundamental to the understanding of environmental issues. They bring together groups of investigators studying differing aspects of an environmental problem to analyze it and contribute to appropriate solutions. In 1996-97, PEEER faculty members have extended the Program's interdisciplinary focus into a major international collaboration on issues of sustainable development. The Alliance for Global Sustainability, described below, has completed its second year of activities, and has embarked upon a research and educational agenda of global scope.

AWARDS

PEEER also awards a fellowship made possible by the Martin Foundation. This year's recipient was Randy Weinstein, a student in the Chemical Engineering Department whose thesis supervisor is Professor Jefferson Tester of the Energy Laboratory. Randy is working in the area of environmental management through corporate culture and change. He is particularly interested in the areas of environmentally benign technologies.

EDUCATION

MIT does an excellent job of educating and advancing the knowledge base for those who see themselves as environmental professionals (in areas like Civil Engineering, Chemical Engineering, Earth, Atmospheric and Planetary Sciences, and Urban Studies and Planning) While promoting these programs, PEEER faculty are also focusing on the much larger group of engineering, science, management, and social science students whose daily professional decisions about materials choice, processing, product design, development strategies and recycling will have substantial implications for the environment.

PEEER has created a four-subject graduate sequence in Chemicals in the Environment which is designed to give graduate and advanced undergraduate students the skills they will need to become effective managers of the environment. The subjects have been developed to provide a systematic and interdisciplinary look at the critical issues of chemicals introduced into the environment and the work place. These subjects, designed for non-majors, are: Chemicals in the Environment: Sources and Controls (Chemical Engineering); Chemicals in the Environment: Chemicals and Human Disease (Toxicology); Chemicals in the Environment: Environmental Fate and Transport (Civil and Environmental Engineering); Chemicals in the Environment: Policy and Management (Urban Studies and Planning). In 1991, this series received the MIT Sizer Award for outstanding contribution to education at MIT.

Led by Professor J. I. Steinfeld, a Traineeship Program funded by the National Science Foundation and located in the Department of Chemistry, focuses on the Chemistry of the Environment. Nine faculty members are carrying out research in diverse areas relating to the production, dispersion, and removal of chemical species in the natural environment, and their interactions with biological systems. A central integrating component of the program is an interdisciplinary Seminar in Environmental Chemistry, which is required of the trainees but is open to all graduate and undergraduate students. The seminar addresses technical, economic, political, and environmental aspects of problems involving the intersection of chemistry and society.

OUTREACH

Several of the initiatives outlined above included outreach to the industries, and governmental agencies, and public interest groups involved in the issues taken up by PEEER. In order to improve problem definition, share research findings, and identify emerging issues of interest to MIT, the program is communicating with these sectors through meetings, invited speakers, and publications.

PUBLICATIONS

PEEER is responsible for the publication of a monthly newsletter *Environmental Calendar*, edited by Dr. Teresa Hill (PEEER and DUSP). The newsletter includes details of upcoming events and synopses of research, editorial comment by faculty members, announcements, and other news of environmental studies at MIT. Special issues of both these publications distribute information about environmental subject offerings each term and for IAP.

ALLIANCE FOR GLOBAL SUSTAINABILITY

The Alliance for Global Sustainability (AGS), an international partnership focused on issues critical to ensuring the sustainability of the global environment, has just completed a very successful first year of activities. PEEER faculty members are active in the research being developed collaboratively through the Alliance. Three major science and technology institutions, the Massachusetts Institute of Technology, the Swiss Federal Institutes of Technology, and the University of Tokyo are the founding members of AGS. With concerns growing world wide to find pathways to future economic and social development that will be harmonious with protection of the environment, and the future of its vital ecosystems, the partners seek to apply scientific and economic disciplines to define new approaches to a sustainable civilization.

In January 1997, researchers affiliated with the AGS met at MIT to begin forming consortia of multidisciplinary research projects designed to address issues in ten thematic areas. The project areas are: Mobility, Energy, Health, Regional Sustainability (watershed scale), Global Change, Environmentally Conscious Design and Manufacturing, Cities of the Future, Regulatory Harmonization and Trade, Framing Sustainability, and Monitoring. Researchers in each thematic area subsequently met throughout the year to discuss and coordinate their work. Several of these workshops and planned activities, in the areas of energy, global change, cleaner technologies, and cities of the future took place during the summer and fall of 1996 and in 1997. Alliance projects are designed to benefit from the differing geographic perspectives of the three institutions' faculties and participants from all continents. Environmental issues of particular significance to developing nations are an additional focus of AGS research. Projects are being structured so that they can achieve maximum synergy among the partner institutions, have major contact with all stakeholders in each decision-making process, and promote world-wide education and communication.

The next annual meeting of the AGS will be held at ETH in Zurich Jan. 22-25, 1998. In addition to the meetings of affiliated faculty from the three founding universities and presentation of ongoing research, the meeting will include the first meeting of the recently appointed AGS International Advisory Board. Stephan Schmidheiny, Swiss

industrialist and author of *Changing Course* and *Financing Change* about the role industry can play in promoting a sustainable future, will serve as the first Chairman of this Board which includes the presidents of the three universities and six additional members.

Professor Marks is coordinating Alliance activities at MIT. The work of the Alliance projects onto the international stage PEEER's founding principles of knowledge-sharing between all sectors; interdisciplinary approaches to complex environmental issues; and the continuing interplay of research and curricula development.

The mission of the New Center for Environmental Initiatives is to conduct research, curriculum development, outreach and public service on the emerging set of 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. It is aimed at forging new relationships between industry, governments, academia and the public to strengthen industry's role as an agent of change in the protection of the environment and sustainability. It is also aimed at developing better synergy between existing MIT efforts in these areas, encouraging new MIT initiatives that complement and broaden them and helping to translate them into MIT educational programs. It will work 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.) It will examine the role of science and technology in forming better environmental policy both from a technical and institutional point of view. It will have a strong commitment to educating a set of emerging environmental and sustainability leaders world wide via joint projects, distance education and special educational programs.

Coordination of the Programs of the Center and relationships with ongoing environmental activities at MIT will be assured through a management team comprised of a faculty Director, Professor David H. Marks of Civil and Environmental Engineering and two Associate Directors, Professor Lawrence Bacow of Urban Planning and Design and Dr. Joanne Kauffman of CEI who will meet regularly with the faculty and management leaders of the individual programs.

Programs of the Center include the following:

MIT Consortium on Environmental Challenges

Objective scientific, technical and economic evaluation of major global environmental issues; Improved policy and decision making on environmental challenges at all level

New Energy Choices (with Energy Lab)

Long term strategies for meeting burgeoning energy demand

Alliance for Global Sustainability

International outreach/networking with other universities worldwide

D. Marks/J. Kauffman

Chemicals in Society

Risk management/ role of the chemical industry

PEER

Curriculum Development/Education- Attention to MIT's literacy and strategy for the environment.

David H. Marks

PROGRAM IN POLYMER SCIENCE AND TECHNOLOGY

PPST, the Program in Polymer Science and Technology, is an interdepartmental graduate education program. The program provides an opportunity for students at MIT to pursue an intensive polymer-centered education that ranges from molecular to continuum concepts in both engineering and science. The program, consisting of a core curriculum and a written and oral qualifying procedure, is administered by faculty from many diverse disciplines located in the departments of Materials Science and Engineering, Chemical Engineering, Mechanical Engineering and Chemistry. Although essentially an academic program, PPST also functions as a fostering community supporting polymer related activities at MIT. In this capacity, the program functions as an intellectual facilitator, bringing together polymer-interested scholars from within the MIT community and from outside academic and industrial institutions. The program also provides an opportunity to coordinate and enhance the material presented in the many different polymer subjects offered throughout the institute.

HIGHLIGHTS

Over the past year, the PPST weekly seminar program was reestablished as the focal point for polymer related activities at MIT. The average attendance at the PPST seminar in both the spring and fall semesters has been about 50 (on at least 4 occasions the attendance was close to 80). We have also seen a significant increase in the number of faculty attending these seminars including faculty participation from Chemistry, Biology, Physics, Nuclear Engineering, Chemical Engineering, Mechanical Engineering and Materials Science and Engineering. The spring semester seminar series ended with a special PPST/DMSE seminar given by Professor Pierre-Gilles De Gennes; the 1991 Nobel laureate in physics.

The PPST faculty approved major changes to the PPST core curriculum this past year. These changes include the addition of a biomaterials and a surface science subject to the core curriculum. Once implemented, the PPST students will now have exposure to subjects that explore polymer synthesis, polymer processing, polymer physical chemistry, the mechanical behavior of polymers, statistical mechanics of polymers, biomaterials and surface science.

Two categories were established for supporters of the PPST program; PPST faculty and PPST affiliates. The former category represents faculty actively involved in the academic development and administration of the program, whereas the latter category represents faculty who are fully committed to the program but not generally involved in the "day-to-day" activities of the program. There are currently 13 PPST faculty and 13 PPST affiliates.

A new PPST recruiting brochure with updated information describing the unique and innovative options and opportunities available to prospective PPST scholars and information on active PPST faculty members and their research interests has been completed. This brochure is modular in design so that it can be used for many purposes and easily updated as needed.

A PPST scholars office (13-5041) was set-up for our first year PPST students. This is an important development as it helps to establish a sense of community between the PPST students and gives them an opportunity to work together in an intensive manner on their common studies.

FUTURE PLANS

Now that a new curriculum has been approved, it will be necessary to work out the details of class scheduling and course selection. Future activities will involve identifying an appropriate biomaterials and surface science subject and working with the instructors of these courses to insure that they are properly connected to the other PPST core subjects.

In addition to implementing our new curriculum, attempts will be made to promote and strengthen strong links with industrial partners and to facilitate mutually beneficial relations with industry. For example, an industrially supported PPST poster competition is currently planned for the coming academic year. An aggressive recruiting campaign is also planned for the coming years. The goal in this case will be to establish a steady-state enrollment of ten students per year.

Michael Rubner

SYSTEM DESIGN AND MANAGEMENT PROGRAM

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; to set the standards for delivering career-compatible professional education using advanced information and communication technologies.

The System Design and Management 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. During 1996-97, Thomas L. Magnanti, George Eastman Professor of Management Science and Professor of Electrical Engineering and Computer Science, served as the program's Management codirector.

The program is targeted for professional engineers with three or more years of experience and offers a 14-course curriculum in systems, engineering, and management subjects, including a project-based thesis, in two program formats: a 13-month in-residence format and a 24-month distance education format, requiring one academic semester in-residence at MIT. The program was conceived as an alternative to the MBA for professional engineers and allows working professionals to pursue a degree without interrupting their careers and relocating themselves and their families.

This year the SDM program admitted its first class of 35 students representing 11 different companies, including two sustaining enterprise companies: United Technologies sponsored 13 students and Kodak sponsored 6. Eight students enrolled in the on-campus program and 27 enrolled as distance learning students. The program began in January with an intensive month in residence for all students, including completion of one and one-half courses, leadership and teamwork exercises, and projects and activities designed to promote cohort-building among students, to mitigate the isolation of the remote education experience.

The SDM program made significant strides in solidifying its new program, bringing together faculty, staff, and students to work out program format and content issues, establish policies and procedures, formulate a strategic action plan, and work on long-term staffing. Specific program accomplishments include:

- Graduating nine students from the original SDM pilot program: seven distance learning students and two in-residence, dual degree students (the remaining two SDM pilot program students are in their final months, completing dual-degree theses).
- Developing three new SDM core courses in system architecture, system engineering, and system and project management, and adapting the content of a number of existing MIT courses; refining the SDM curriculum and developing the content of the January program and the initial spring, summer and fall business trips.
- Admitting 35 students to the first full offering of the SDM program and enrolling two sustaining enterprise partners.
- Delivering three distance education courses using multipoint videoconferencing to broadcast real-time MIT courses to 15 company sites and to conduct recitation sessions and tutorials; using videotapes of live classes, supplemented by interactive videoconferencing discussion sessions; and using Internet resources to supplement live course material, provide reference information, and allow for interactive chats.
- Developing a strategic plan for SDM and a future staffing plan that incorporates the concept of shared staff resources among other MIT programs with similar content and objectives (the Leaders for Manufacturing Program and the Center for Innovation and Product Design, with whom we are exploring this idea).
- Establishing cooperative relationships among administrative units to work out issues of incorporating non-standard students into the MIT system.
- Standardizing policies and procedures for SDM distance education students, including guidelines on SDM course requirements, transfer credit, semester-in-residence, business trips, thesis preparation, use of MIT intellectual property (broadcast, print, software, videotape, and Internet materials), and Graduate School regulations.
- Appointing an Engineering codirector, John R. Williams, Professor of Civil and Environmental Engineering.

Thomas L. Magnanti, John R. Williams

TECHNOLOGY AND POLICY PROGRAM

The Technology and Policy Program is a graduate educational program in the School of Engineering. It educates men and women for leadership on the important technological issues confronting society. It prepares its graduates to excel in their technical fields, and to develop and implement effective strategies for dealing with the risks and opportunities associated with these technologies.

The Technology and Policy Program aims to be the educational leader in the field. With about 150 students on campus and about 600 graduates, it is now the largest of its kind in the world. With its extensive international connections with other universities, it is building a network of relationships to define the field.

EDUCATIONAL PROGRAMS

The Technology and Policy Program sponsors both a Master of Science and an Interdepartmental Doctoral Program.

This year's class for the Master of Science in Technology and Policy included 60 students, the largest ever. The winners of the Award for Best Thesis in Technology and Policy were Joseph Bambenek and Douglas Melcher. The winner of the Alumni Award for Leadership and Excellence in Technology Policy was Lynn Yang, for her development and delivery of environmental subjects in local high schools.

This interdepartmental effort, the Doctorate in Technology, Management and Policy, enrolls about 25 students in their 2nd to 5th year of graduate school. The first 4 participants received their doctorates this year, and proceeded to faculty positions at the Georgia Institute of Technology College of Management, Policy and International Affairs; the London School of Economics and Politics; and the University of Chile.

The Technology and Policy Program now runs an internship program as an integral part of its curriculum. This first year of activity placed over 30 interns in major policy centers in the United States and abroad. One of the Rhodes Scholars in the Technology and Policy Program served as an intern for MIT President Vest.

The internship program is funded by major corporations and by individuals who generously support public service internships, for example with the US Congress, the Massachusetts legislature and non-profit organizations.

Noteworthy endowments provided the following awards:

- The Marvin and Joanne Grossman Award for International Understanding, given to Susan Pickett for an internship with Senator Hayashi in the Japan Upper House;
- The Donald F. Cooke for Public Service, to Jeffrey Loiter for working with Massachusetts State Senator Lois Pine; and
- The Francis Y.-H. Chin Award for Public Service, to Robert Cheng for working in Washington with the Science and Technology Board.

The Technology and Policy Program actively maintains relations with many universities and educational agencies, particularly in France, Japan and the United Kingdom.

Two new associations were initiated this year with:

- The Technical University of Delft (Netherlands), involving exchanges of faculty and the participation of Prof. de Neufville in the Dutch national review of Technology Policy programs in the Netherlands, and
- The Instituto Superior Tecnico of Portugal, involving student and faculty exchanges and collaborative projects designed to establish a Technology Policy Program at that university.

Particularly noteworthy this year is Ms. Elizabeth Stock:

- Named by President Clinton to be a White House Fellow assigned to Vice President Gore; and
- Elected to the MIT Corporation as a Representative of Recent Graduates.

More information about this Program can be found on the World Wide Web at the following URL:

<http://web.mit.edu/tpp/www/>

Richard de Neufville

TECHNOLOGY, MANAGEMENT AND POLICY PROGRAM

The Technology, Management and Policy Program (TMP), established in 1992, is a multidisciplinary doctoral program focusing on research to improve methods in defining and implementing policies for the intelligent use of technology. Currently having 25 doctoral candidates, the Program brings together and coordinates several MIT research centers and educational programs in technology, management, and policy issues linked to large-scale systems.

Together with its master's program, the Technology and Policy Program doctoral program involves over 40 faculty and research staff, US \$10 million of annual research funding, and about 200 graduate students. Graduates from this program go on to work for industry or government from Tokyo to Paris to Washington, D.C.

The participants in this Ph.D. Program share a common vision. Each emphasizes dual competency—in a technical area and in management and policy—as the basis for the effective design of large-scale systems. Together they are developing a new paradigm for engineering systems planning and design, a paradigm that blends technical expertise with competence in economics, management, and policy to achieve better adaptation of technology to societal goals. A primary purpose of TMP is to diffuse throughout the education and practice of engineering the expertise in systems technology and policy that has been developed in the individual centers involved in the Program.

The centers and laboratories that constitute the Program have each achieved considerable worldwide recognition in their specialized fields over the past 20 years. By working together they can pursue research on large-scale systems and establish interdisciplinary curricula more easily than they could do individually.

The Program's objectives include:

- Participating in major research projects in close cooperation with major national laboratories and international organizations;
- Establishment of a significant team of faculty and staff who work closely together in technology, management, and policy;
- Creation of new educational opportunities in large-scale systems by building on the existing capabilities of the Technology and Policy Program.

CENTERS AND LABORATORIES

Center for Technology, Policy and Industrial Development: The name of the CTPID was selected to underscore the important linkages between technology, policy, and industrial development. The central objective of the Center is to define these linkages and to develop policy alternatives that meet pressing social concerns.

Center for Construction Research and Education: CCRE was established at MIT in 1982 to provide a research environment conducive to the development and application of innovative construction technologies and management principles; to offer graduate programs in construction engineering and management; and to act as a facilitator and catalyst for improving the productivity and competitiveness of the engineering and construction industry and to enhance its contribution to the economy and society in general.

Center for Transportation Studies: CTS was established in 1973 to develop and coordinate a 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 at MIT. The interchange of information, ideas, and inspiration among its faculty, students, and research staff makes it one of the most dynamic centers of activity in the transportation field.

The Materials Systems Laboratory: MSL is internationally recognized for its innovative work on the competitive position of materials and products in automotive, aerospace, electronic, and environmental applications. It fosters a

unique combination of knowledge of the design and production processes used in industry together with managerial economics.

Program for Environmental Engineering Education and Research: PEEER explores the relationship between technology and a sustainable environment. This new initiative builds upon MIT's extensive strengths in environmentally oriented education and research activities.

Daniel Roos

SCHOOL OF HUMANITIES AND SOCIAL SCIENCE

The School of Humanities and Social Science (SHSS) continues to focus its efforts on affirmative action, fund-raising, and faculty recruitment in departments and sections which are experiencing retirements and resignations, in particular History, Linguistics & Philosophy, and Political Science. The faculty within the School received a number of honors and awards, and some important administrative changes within the School have occurred.

UNDERGRADUATE EDUCATION

There has been much discussion this year of the new Communication Requirement which is being designed and will be implemented Institute-wide. The goal is to cooperate as effectively as possible with other groups responsible for overseeing the requirement, such as the new subcommittee of the CUP, to determine which HASS subjects will be "communication intensive" and how they will be configured. The "HASS Overview Committee" has a new name and a broader charge to reflect its involvement in this effort.

We continue to monitor the change in the HASS-D Requirement -- implemented in order to include Category 3, Visual and Performing Arts, in the requirement -- to see what, if any, impact it has had on enrollments in Categories 1 and 2, the Humanities. A thoroughgoing review of the HASS system, planned for 1998-99, will include this and other aspects of the HASS-D Requirement.

NEW INITIATIVES

Various new initiatives within the School are underway, some of which were launched in the previous few years. The Writing Initiative, which is a collaborative project between the School of Humanities and Social Science and the School of Engineering, has been a major contributor of ideas and experiments to the MIT faculty's ongoing effort to design a new Communications Requirement. After considerable discussion across the MIT campus, the MIT faculty has called for a number of curricular experiments in preparation for the implementation of such a requirement, to begin (pending a positive vote of the faculty) in the year 2000.

The Media Studies Committee, chaired by Associate Professor Henry Jenkins of the Literature Faculty, continued to develop a proposal for a new graduate program in Media Studies which would be focused on the Humanities. It is possible that a final proposal will be voted on by the MIT faculty in fall or spring 1998. Several film and media studies scholars from around the country came to campus to present their scholarship as part of a broad effort to recruit new faculty in media studies to the School. A half million dollar grant from the Markle Foundation which focuses in large part on the new media and communications will help to enrich media studies in the School.

MIT has made important contributions to knowledge over the past half-century in a variety of areas, including the social sciences. In order to help ensure that the social sciences remain strong at the Institute, the Dean appointed a Working Group on the Future of the Social Sciences, chaired by Professor Paul Joskow (Head of Economics). Working Group members include Professor Richard Samuels (Head of Political Science), Professor Joshua Cohen (Philosophy and Political Science), Associate Professor Kenneth Oye (Political Science and Director of the Center for International Studies), Associate Professor Stephen Ansolabehere (Political Science), Professor Bengt Holmstrom (Economics), Professor Lawrence Bacow (Urban Studies and Planning and Chair of the MIT Faculty), and Dean Philip S. Khoury (History). The Committee interviewed the deans of Engineering (Professor Robert Brown) and the Sloan School of Management (Professor Glen Urban) and faculty in SHSS, Urban Studies and in Sloan as part of its effort to catalogue MIT's social science resources. The Working Group will complete in Fall 1997 a report on the state of the social sciences which will offer recommendations for how to strengthen them at MIT. The report will then be presented to the President, Provost, the academic deans, and the appropriate academic councils.

AFFIRMATIVE ACTION

The affirmative action record of SHSS 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. The School's record relative to the pool, however, is about average. Within the School for 1996-97 there were 40 women faculty, which represents 28 percent of the total. Of these 22 are tenured (25 percent of the tenured faculty). Over the past five years, the total number of women faculty has steadily increased (32 in 1991-92), and the School is making every effort to continue this trend. We were successful in recruiting three women to the faculty for next year

(one in Literature and two in Writing and Humanistic Studies), and a fourth who will join the History Faculty in FY99. In addition, we are hopeful that a fifth (in Anthropology) will get approval next fall. The number of women faculty in 1997-98 will be 41 (42 if we include the Anthropologist).

The School's record with respect to minority faculty is less satisfactory than it is with respect to women, although we continue to make steady progress. Our efforts toward increasing the minority representation on the faculty has led to the successful recruitment of two minority women (one African-American and one Asian-American) as assistant professors in the Program in Writing and Humanistic Studies next year. SHSS also continues to pursue non-traditional methods in the hope that they will lead to faculty appointments, such as the appointment of an African-American male in Music and Theater Arts, hired two years as an instructor, while working to complete his Ph.D. He received his doctorate in June and will join the faculty as an assistant professor in 1997-98. The total number of minority faculty in the School this year, including Asian Americans, was 20 (14%); next year (1997-98) the number will increase to 22 (15%).

While the School's efforts to recruit minority administrative staff members appears more successful than our efforts to recruit minority faculty members, there's room for improvement. Currently, we have four minorities (one African-American, one Hispanic, and two Asian-Americans) of a total of 21 (19%). We remain committed to further increasing the number of minority faculty and administrative staff members and will continue to carefully monitor the affirmative action efforts of the Departments and Programs in the School.

HONORS AND AWARDS

The faculty within the School of Humanities and Social Science garnered an impressive array of honors and awards this year. The most notable among them were the following: The Department of Economics' Professor Peter Diamond was named an Institute Professor; Associate Professor Michael Kremer received the Presidential Early Career Award for Scientists and Engineers and the prestigious MacArthur Fellowship; Professor Abhijit Banerjee became a Fellow of the Econometric Society and received a MacArthur Foundation Grant; and Professor Bengt Holmstrom received the Department of Economics Graduate Teaching Award and the 1997 Economics Prize from the Economics Society of Finland. Professor Cynthia Wolff of the Program in Writing and Humanistic Studies won both a Guggenheim and a National Endowment for the Humanities grant for the next two years. The Department of Linguistics and Philosophy's Institute Professor Noam Chomsky was awarded the Helmholtz Medal by the Berlin-Brandenburgische Akademie Wissenschaften and an honorary doctorate by the Universidad de Buenos Aires; Ferrari P. Ward Professor Kenneth Hale was awarded an honorary doctorate by the University of Arizona. Among the History faculty, Professor Harriet Ritvo and Associate Professor Anne McCants won an award from the Class of '51 Fund for Excellence in Education and the Class of '55 Fund for Excellence in Teaching for their project "History at the Bench: Reading and Writing About Modern Europe"; and Dean Philip S. Khoury was elected President of the Middle East Studies Association of North America. In the Music and Theater Arts Section, Professor Ellen Harris received the Class of 1949 Professorship, and Professor Lowell Lindgren became a Margaret MacVicar Faculty Fellow and received the Luise Vosgerchian Teaching Award from Harvard University. The Department of Political Science's Assistant Professor Melissa Nobles was awarded the Cecil and Ida Green Career Development Professorship; and Professor Myron Weiner was appointed chair of the newly formed External Research and Advisory Committee of the United Nations High Commissioner for Refugees, Geneva. Foreign Languages and Literatures' Associate Professor of German Studies and Director of the MISTI-MIT Germany Program Bernd Widdig was honored with the Levitan Prize in the Humanities; and Assistant Professor of Japanese Takako Aikawa was awarded the Mitsui Career Development Professorship. Professor Loren Graham of the Program in Science, Technology and Society (STS) received the George Sarton Medal from the History of Science Society "for a lifetime of professional contributions to the history of science." In addition, STS' Professor Evelyn Fox Keller received an honorary doctorate from Lulea University in Sweden; and Professor Merritt Roe Smith received an honorary doctorate from the Rensselaer Polytechnic Institute in recognition of his "outstanding contributions to the history of technology." Among the Literature faculty, Class of 1956 Associate Professor James Buzard was appointed Fellow of the National Humanities Center; and Professor Ruth Perry was elected second vice-president of the American Society for Eighteenth Century Studies.

FUNDRAISING

Fundraising for the School of Humanities and Social Science is beginning to show results from the new systems designed and implemented to connect SHSS inextricably with the Institute's initiatives as well as the interests of our alumni.

SHSS embarked on its first corporate partnership with Booz-Allen & Hamilton. The partnership was announced and launched at a one-day symposium here at MIT. Subsequent interactions have had SHSS faculty participating in BAH conferences around the country. The partnership examines the societal impacts of how "intellectual capital" is quantified, qualified, and applied in this new technological age.

A single donor's significant gift to the Dean's Unrestricted Fund will provide critical seed funding to start-up projects which do not fit neatly in traditional Humanities fundraising or technology fundraising proposals.

The Linguistics Section of the Department of Linguistics and Philosophy secured funding from the Research Development Corporation of Japan for its Mind Articulation Project. Work on the Mind Articulation Project, which represents a collaborative effort with the Brain and Cognitive Science Department, began this year and will be enhanced by the addition of an MEG machine, Magnetoencephalography (MEG). MEG imaging techniques are used in this project to investigate how the brain represents and uses linguistic categories.

The Literature Faculty received a major grant from the Markle Foundation to establish "Programs on Media in Transition." The first two-day conference was held at MIT in May 1997. The web project and subsequent seminars, conferences, and lectures, will continue to be presented throughout 1997-98.

This year marked the renovation and dedication of the Music Library. This project was completed through the concerted efforts of the Friends of Music and Theater Arts and the Council for the Arts at MIT.

The Foreign Languages and Literatures Section continues to push the boundaries of technology in language acquisition and also in securing financial support from traditional as well as new foundations and corporations. Professor Shigeru Miyagawa continues to break new ground in corporate and government support for Japanese studies. Senior Lecturer Gilberte Furstenberg and Lecturer Shoggy Waryn received a National Endowment for the Humanities Grant for Teaching with Technology for their new Multimedia Cross-Cultural Project for CD-ROM and Web, designed to increase understanding of French culture. Associate Professor Bernd Widdig secured funding this year from the German Federal Ministry of Research, Education, and Technology for the MIT International Science and Technology Initiative Internship Program. He also worked to establish the Lufthansa Award for Excellence in German Studies at MIT and the Max Kade Distinguished Visiting Professorship/Lecturer in German Studies at MIT.

The MIT International Science and Technology Initiative (MISTI), under the leadership of Professor Suzanne Berger of the Department of Political Science, and with the support of the Freeman Foundation, fully established the MISTI China and German Program. Thirty interns were placed in China as of summer 1997 and 21 interns were placed in Germany.

The Department of Economics' World Economy Laboratory (WEL) continues to attract individual and corporate members from around the world. It has also successfully completed funding the Robert Solow endowed graduate fellowships.

ADMINISTRATIVE CHANGES, RETIREMENTS

The School saw one retirement and seven resignations this year, including four due to the denial of tenure and/or promotion. Four faculty were promoted to tenure, effective July 1, 1997: Glenn Ellison and Jonathan Gruber of the Department of Economics, Mary Fuller of the Literature Section, and Evan Ziporyn of the Music and Theater Arts Section.

The School was successful in recruiting six new members to the faculty (all assistant professors) effective 1997-98. They include one in Economics, one in Linguistics and Philosophy, one in History, one in Literature, and two in Writing and Humanistic Studies. In addition, a seventh assistant professor (History) will join the faculty effective July 1, 1998, and there are several possible senior faculty appointments still pending.

Professor Robert Stalnaker will become the next Head of the Department of Linguistics and Philosophy, replacing Professor Wayne O'Neil. Professor Joshua Cohen replaces Professor Richard Samuels as Head of the Department of Political Science, and Professor James Paradis replaces Professor Alan Lightman as Head of the Program in Writing and Humanistic Studies. We will miss the insights and administrative wisdom of Professors O'Neil, Samuels, and Lightman, and wish them well as they return to professional lives focused on full-time scholarship and teaching.

Sadly, we report the death of a valued colleague on the History Faculty: Emeritus Professor Thomas Mahoney, an expert on the 18th Century British statesman Edmund Burke, on April 21, 1997.

Philip S. Khoury

HUMANITIES, ARTS, AND SOCIAL SCIENCE OFFICE

The new version of the electronic HASS Guide went on-line successfully beginning Fall 1996 and, together with its hard-copy twin, has proven to be quite popular with undergraduates. During 1996-97, the HASS Office relied more heavily upon email to communicate with students on various matters—regarding HASS Concentration and Minor forms, for instance—with good results. It is more efficient, less expensive, and seems to elicit a higher rate of response from students. Also during this year, we received all new equipment (computers and printer) in order to be compatible with S.A.P. As a result, we have spent time making everything work smoothly, including upgrading software to match the new operating system. Currently, we are working together with the Registrar's Office and Information Systems toward integrating the HASS-D Lottery with the Registrar's Office's new on-line registration system for students. The target date for implementation is Spring 1998.

In addition, the HASS Office has continued to serve multiple functions, including the administration of the eight-subject HASS requirement, the HASS Minor, the Harvard Cross-Registration Program, provision of statistics for the School of Humanities and Social Science, and the publication of The HASS Guide (hard copy and electronic versions) each term. This office also continued to record proposals and completion forms for HASS Concentrations and Minors in MITSIS, on behalf of the Registrar's Office, in addition to maintaining a HASS Minor data base and paper files. Petitions for HASS credit for subjects which are not so coded in MITSIS, including Harvard and Wellesley subjects, graduate subjects, etc., are submitted here for approval. Information concerning any of the above, as well as HASS transfer credit and general Institute information, was provided to the MIT community and in response to inquiries from outside the Institute. The Coordinator, Dr. Bette Davis, served as staff to the HASS-D Overview Committee, chaired by Professor James Paradis.

ENROLLMENT STATISTICS

The number of HASS subjects offered remained approximately the same—455 in 1996-97, compared to 459 last year. The number of autonomous sections again decreased slightly, from 598 to 591. The number of HASS-Distribution subjects offered was exactly the same as last year—113. The largest overall enrollments were in the same fields as last year, in exactly the same order: 1898 in Economics and 1538 in Foreign Languages and Literatures. Writing (1014) moved from fourth to third place, followed by Literature (943) and Music (816). (Six-unit music performance subjects are not included in these statistics.) The following fields showed the greatest increases over last year, in terms of percentage: Linguistics (from 45 to 82), and the History of Art and Architecture (from 94 to 138).

CONCENTRATIONS

Economics and Foreign Languages again led in the number of completed HASS Concentrations: in 1996-97, 320 (compared to 316 last year) students completed concentrations in Economics, and 222 (compared to 260 last year) completed concentrations in Foreign Languages & Literatures. (For a breakdown by languages, see Table II.) The next two most popular HASS Concentration fields are Music, with 110 completed concentrations, and Psychology, with 95, followed by Writing (71), History (54), and Literature (51).

MINOR PROGRAMS

After an unexplained decrease last year, the number of HASS Minors was up in 1996-97. The number of HASS Minors received by the Class of 1997 reached an all-time high of 222, compared to 170 in 1996 and 201 in 1995. A total of 440 HASS Minor applications from all graduating classes were submitted, compared to 416 in 1995-96. The two most popular fields in terms of applications filed were the same as last year: Economics (124) and Music (69). There were 59 minors in Foreign Languages (14 in French, 23 in German, and 22 in Spanish). Other popular HASS Minors, in order, were Writing (34), Psychology (29), Literature (25), and Political Science (24).

HARVARD CROSS REGISTRATION

The number of MIT undergraduates cross-registering for courses at Harvard showed a slight increase in 1996-97. In 1996-97, 213 MIT undergraduates took 235 subjects at Harvard, compared to 199 students enrolled in 214 subjects in 1995-96. As usual, foreign languages proved to be by far the most popular field of study. One hundred and thirteen of the 235 subjects were in 18 different foreign languages. The two most popular languages were Chinese (29) and Korean (17); enrollments in other languages were spread fairly evenly. The most popular fields outside foreign languages were Philosophy (24) and Biology (17).

S.B. DEGREES

In Course 14, Economics, 45 students received the S.B. Degree, while 10 students received degrees in Political Science, Course 17. During the same time period, September 1996 through June 1997, a total of 23 students completed the S.B. Degree in Humanities, Course 21. Of these, nine received joint degrees, four in 21-E and five in 21-S. Another 12 received degrees in a specified field within Course 21. Two undesigned Humanities degrees (for "Major Departures") were granted. Four students received the S.B. in Philosophy.

UNDERGRADUATE MAJORS

The Economics Department has 99 undergraduate majors, and 21 undergraduate students are majoring in Political Science. (These figures represent only first degrees.) There were 59 Humanities majors in 1995-96; 31 of these were first degrees. Of the 59, 24 were joint majors (8 in 21-E and 16 in 21-S.) Literature had the most majors (15), followed by Writing (13) and Music (12). Eight undergraduates have officially declared a major in Philosophy.

HONORS AND AWARDS

Among the more notable honors achieved by SHSS majors this year were:

Robert A. Boit Writing Prize: Amy M. Smith, '98, First Prize (essay); Christina Kalb, '98, Second Prize (poetry); and Anthony Julian, '97 Honorable Mention

Burchard Scholars: Elizabeth Schofield, '98; Katharine Spayde, '99; Robinanne Jayne Stancavage, '98; Farhan Zaidi, '98.

Edward S. Darna Award: Charles Armesto, '97

Peter J. Eloranta Award: Joaquin Terrones, '97

Prize for Excellence in Economics Writing: Daniel Witalec, '97; Sirshendu Banerjee, '97; Peter Chu, '97; Nada Mora, '98

Ford Foundation Baccalaureate Incentive Award: Richard Thompkins, '98

I. Austin Kelley Prize: Lori Fujitake, '97, Honorable Mention

Ragnor and Margaret Naess Award: Nicole Lee, '98

Phi Beta Kappa: Richard Lee, '97; Daniel Witalec, '97; Sung Jun Woo, '97; Jason Strautman, '97

Gregory Tucker Memorial Prize: Gary Crichlow, '97

Dewitt Wallace Prize: Jennifer Murphy, '99, First Prize; Christina Kalb, '98, Honorable Mention

Laya and Jerome B. Wiesner Award: Solomon Douglas, '97

Bette Davis

ENROLLMENT IN HUMANITIES, ARTS, AND SOCIAL SCIENCES SUBJECTS: 1996-97

| Field | Elective Subjects | | | HASS Distribution | | | Total Enrollment | | |
|-------------------------------------|-------------------|------------|--------------|-------------------|------------|--------------|------------------|------------|---------------|
| | #Subjects | #Sections | #Students | #Subjects | #Sections | #Students | #Subjects | #Sections | #Students |
| Anthropology | 14 | 14 | 221 | 5 | 7 | 208 | 19 | 21 | 429 |
| Archaeology | 5 | 5 | 85 | 0 | 0 | 0 | 5 | 5 | 85 |
| Economics | 24 | 45 | 1,846 | 2 | 2 | 52 | 26 | 47 | 1,898 |
| Foreign Languages and Literature | 57 | 86 | 993 | 22 | 38 | 545 | 79 | 124 | 1,538 |
| History | 28 | 29 | 277 | 14 | 17 | 390 | 42 | 46 | 667 |
| History of Art & Architecture | 2 | 2 | 26 | 4 | 6 | 112 | 6 | 8 | 138 |
| Linguistics | 5 | 6 | 82 | 0 | 0 | 0 | 5 | 6 | 82 |
| Literature | 34 | 39 | 374 | 18 | 26 | 569 | 52 | 65 | 943 |
| Music* | 20 | 25 | 315 | 10 | 20 | 501 | 30 | 45 | 816 |
| Philosophy | 17 | 17 | 233 | 6 | 6 | 271 | 23 | 23 | 504 |
| Political Science | 22 | 22 | 295 | 8 | 8 | 236 | 30 | 30 | 531 |
| Psychology | 8 | 9 | 373 | 1 | 1 | 354 | 9 | 10 | 727 |
| STS | 13 | 13 | 74 | 5 | 5 | 148 | 18 | 18 | 222 |
| Theater Arts* | 25 | 29 | 275 | 3 | 3 | 35 | 28 | 32 | 310 |
| Urban Studies | 11 | 11 | 190 | 2 | 2 | 31 | 13 | 13 | 221 |
| Visual Arts | 9 | 9 | 80 | 2 | 5 | 115 | 11 | 14 | 195 |
| Women's Studies | 7 | 7 | 36 | 4 | 4 | 30 | 11 | 11 | 66 |
| Writing | 34 | 59 | 936 | 4 | 4 | 78 | 38 | 63 | 1,014 |
| Other Subjects | 7 | 7 | 54 | 3 | 3 | 152 | 10 | 10 | 206 |
| Totals | 342 | 434 | 6,765 | 113 | 157 | 3,827 | 455 | 591 | 10,592 |

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.

*Music and Theater Arts 6-unit performance subjects are not included in these statistics.

CONCENTRATIONS IN ALL FIELDS OF THE HUMANITIES, ARTS, AND SOCIAL SCIENCES SUBJECTS* JUNE 1997

| Fields of Concentration | Class of 2000 | Class of 1999 | Class of 1998 | Class of 1997 | Total in Fields |
|-------------------------------|---------------|-----------------|------------------|----------------------|----------------------|
| American Studies | (0) 0 | (1) 0 | (3) 0 | (8) 8 | (12) 8 |
| Ancient & Medieval | (0) 0 | (3) 1 | (6) 2 | (5) 5 | (14) 8 |
| Anthropology | (0) 0 | (10) 0 | (36) 11 | (41) 37 | (87) 48 |
| Black Studies | (0) 0 | (0) 0 | (3) 2 | (1) 1 | (4) 3 |
| Constitutional Tradition | (0) 0 | (1) 0 | (0) 0 | (0) 0 | (1) 0 |
| East Asian Studies | (0) 0 | (14) 1 | (14) 4 | (30) 30 | (58) 35 |
| Economics | (0) 0 | (122) 3 | (134) 45 | (300) 272 | (556) 320 |
| Ethnic Studies | (0) 0 | (0) 0 | (0) 0 | (0) 0 | (0) 0 |
| Film & Media Studies | (0) 0 | (5) 0 | (16) 2 | (11) 11 | (32) 13 |
| Foreign Languages** | (7) 0 | (90) 6 | (125) 43 | (195) 173 | (417) 222 |
| History | (1) 0 | (12) 1 | (14) 5 | (54) 48 | (81) 54 |
| History of Art & Architecture | (0) 0 | (0) 0 | (5) 1 | (2) 2 | (7) 3 |
| Labor In Industrial Society | (0) 0 | (0) 0 | (0) 0 | (1) 1 | (1) 1 |
| Latin American Studies | (0) 0 | (1) 0 | (1) 0 | (7) 5 | (9) 5 |
| Linguistics | (1) 0 | (2) 1 | (8) 4 | (4) 4 | (15) 9 |
| Literature | (0) 0 | (21) 0 | (40) 8 | (47) 43 | (108) 51 |
| Middle Eastern Studies | (0) 0 | (1) 0 | (0) 0 | (0) 0 | (1) 0 |
| Music | (1) 0 | (43) 1 | (56) 10 | (110) 99 | (210) 110 |
| Philosophy | (0) 0 | (15) 1 | (11) 2 | (36) 35 | (62) 38 |
| Political Science | (2) 0 | (26) 0 | (22) 4 | (41) 36 | (91) 40 |
| Psychology | (1) 0 | (29) 2 | (39) 18 | (76) 75 | (145) 95 |
| Religion | (0) 0 | (1) 0 | (0) 0 | (2) 1 | (3) 1 |
| Russian Studies | (0) 0 | (0) 0 | (1) 0 | (0) 0 | (1) 0 |
| Science, Technology & Society | (1) 0 | (9) 0 | (8) 1 | (23) 21 | (41) 22 |
| Theater Arts | (0) 0 | (5) 0 | (19) 5 | (25) 22 | (49) 27 |
| Urban Studies | (0) 0 | (1) 0 | (9) 4 | (12) 10 | (22) 14 |
| Visual Arts & Design | (0) 0 | (3) 0 | (4) 0 | (7) 7 | (14) 7 |
| Women's Studies | (0) 0 | (4) 2 | (8) 2 | (11) 11 | (23) 15 |
| Writing | (0) 0 | (17) 0 | (29) 3 | (79) 68 | (125) 71 |
| Special Concentrations | (0) 0 | (0) 0 | (4) 0 | (2) 2 | (6) 2 |
| Totals | (14) 0 | (436) 19 | (615) 176 | (1,130) 1,027 | (2,195) 1,222 |

*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 | (10) 0 | (12) 4 | (9) 7 | (31) 11 |
| ESL | (0) 0 | (0) 0 | (3) 1 | (2) 2 | (5) 3 |
| French | (3) 0 | (23) 3 | (36) 16 | (48) 44 | (110) 63 |
| German | (2) 0 | (21) 2 | (21) 4 | (22) 19 | (66) 25 |
| Japanese | (1) 0 | (20) 1 | (22) 8 | (57) 54 | (100) 63 |
| Other Languages | (0) 0 | (2) 0 | (2) 0 | (1) 0 | (5) 0 |
| Spanish | (1) 0 | (14) 0 | (28) 10 | (54) 45 | (97) 55 |
| SILC | (0) 0 | (0) 0 | (1) 0 | (2) 2 | (3) 2 |
| Totals | (7) 0 | (90) 6 | (125) 43 | (195) 173 | (417) 222 |

UNDERGRADUATE MAJORS

| Year | Economics | Humanities* | Philosophy | Political Science | Total |
|---------|-----------|-------------|------------|-------------------|------------|
| 1987-88 | 76 | 77 | 9 | 40 | 202 |
| 1988-89 | 103 | 52 | 11 | 43 | 209 |
| 1989-90 | 111 | 51 | 13 | 54 | 229 |
| 1990-91 | 115 | 64 | 13 | 44 | 236 |
| 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 |

*These figures do not include double majors who registered first in a course other than Humanities.
(If you include double majors, the figure is 59.)

GRADUATE STUDENTS

| Year | Economics | Hist & Soc Study of Sci & Tech | Linguistics & Philosophy | Poli Sci | Total |
|---------|-----------|--------------------------------------|-----------------------------|----------|------------|
| 1987-88 | 120 | - | 72 | 157 | 349 |
| 1988-89 | 127 | 4 | 67 | 118 | 316 |
| 1989-90 | 132 | 9 | 77 | 154 | 372 |
| 1990-91 | 134 | 13 | 61 | 154 | 362 |
| 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 |

HASS MINOR APPLICATIONS FOR CLASSES OF 1997, 1998, 1999, AND 2000

| FIELD | TOTAL APPLICATIONS |
|---------------------------------|--------------------|
| Anthropology | 8 |
| Economics | 124 |
| Film and Media Studies | 5 |
| Foreign Languages | |
| French | 14 |
| German | 23 |
| Spanish | 22 |
| History | 7 |
| History of Art & Architecture | 2 |
| Linguistics | 7 |
| Literature | 25 |
| Music | 69 |
| Philosophy | 4 |
| Political Science | 24 |
| Psychology | 29 |
| Regional Studies Minor Programs | |
| African & African Diaspora | 1 |
| East Asian Studies | 13 |
| European Studies | 0 |
| Latin American Studies | 4 |
| Middle Eastern Studies | 0 |
| Russian Studies | 4 |
| Science, Technology & Society | 3 |
| Theater Arts | 9 |
| Urban Studies and Planning | 3 |
| Women's Studies | 6 |
| Writing | 34 |
| Total Minor Applications | 440 |

*Includes February, and June 1997, and September 1996 candidates.

DEPARTMENT OF ECONOMICS

The goal of the MIT Department of Economics is to be the best economics department in the world. To achieve this goal, we strive to maintain both the best Ph.D. program in economics and an outstanding faculty of research leaders. We also endeavor to provide an outstanding education in economics for MIT undergraduates and to encourage our faculty to continue their active and successful public service activities in the United States and abroad.

HIGHLIGHTS OF THE YEAR

The scientific and academic activities of the Economics department continued at a strong pace during the year. Associate Professors Jonathan Gruber and Glenn Ellison were given tenure and promoted to the rank of Professor at the same time, both effective July 1. Professor Gruber's areas of specialty are public finance and health economics. Professor Ellison's areas of specialty are economic theory and industrial organization. Three Assistant Professors were promoted to the rank of Associate Professor (without tenure) to be effective July 1. One senior faculty member and two junior faculty members joined the Department. We completed a search and appointed an additional junior faculty member in the field of econometrics effective July 1, 1997. Three junior faculty members were awarded Career Development Chairs. The Department continues to search for one senior appointment in economic theory and three junior faculty at the Assistant or untenured Associate Professor rank.

Professor Peter Diamond was named an Institute Professor which brings great prestige to himself and the Department. Associate Professor Michael Kremer received the Presidential Early Career Award for Scientists and Engineers and the prestigious MacArthur Fellowship.

Once again, the Department competed aggressively with Stanford, Harvard, and Princeton, for the AY 97-98 crop of new Ph.D. students. We were successful in attracting an excellent class for the fall 1997 term.

The Department completed an upgrade of its existing graduate student computer cluster and added an undergraduate computer cluster using funds from an NSF (ARI) equipment grant, funds from MIT, and gifts from alumni. The Department received a gift from the Sirivadhanabhakdi Foundation for equipment and UROP support for the undergraduate computer cluster. These upgrades will help the Department to close the gap in computational resources that exists with other leading economics departments. The Department has also submitted a proposal to Intel for advanced computer equipment. The funding of the Robert M. Solow Endowment Fund has been largely completed and the first Solow Endowment Fund Fellow was appointed and completed his first year of graduate studies. The Castle International Graduate Student Fellowship was 50% funded and the first Castle International Fellow will be in next year's first year class of Ph.D. students.

HONORS AND AWARDS

Professors Diamond and Bengt Holmstrom, and Associate Professor Lones Smith received new NSF awards. Associate Professor Daron Acemoglu and Assistant Professor Jorn-Steffen Pischke received a Citibank Grant. Assistant Professor Susan Athey is a Faculty Research Fellow at the National Bureau of Economic Research. Professor Abhijit Banerjee became a Fellow of the Econometric Society, and received a MacArthur Foundation Grant. Professor Olivier Blanchard served as the Vice President of the American Economic Association. Professor Ricardo Caballero was an invited lecturer at the Econometric Society. Professor Diamond served as Chair of the Board and President of the National Academy of Social Insurance and gave keynote addresses at both the Midwest Macro Conference and the Governor's Conference on Aging. Professor Ellison was selected as a fellow by the Center for Advanced Study in the Behavioral Sciences. Professor Gruber continues as Associate Editor of the *Journal of Public Economics*. Associate Professor Jeffrey Harris served on the National Research Council's Committee on Risk Characterization. Professor Holmstrom received the Department of Economics Graduate Teaching Award and the 1997 Economics Prize from the Economics Society of Finland. Professor Kremer is Health and Aging Fellow at the National Bureau of Economic Research. Professor James Poterba received Honorable Mention in the TIAA-CREF Paul Samuelson Prize for Research on Lifetime Financial Preparation, and continues as Co-Editor of the *Journal of Public Economics*. Assistant Professor Jaime Ventura is Associate Editor of the *Review of Economics and Statistics*.

The World Economy Laboratory (WEL) directed by Professor Rudi Dornbusch continued to thrive and provide valuable resources for the Department. WEL conferences were held in Washington, and Cartagena, Columbia during

the academic year. WEL supported two Russian graduate students, provided research support for others, and funded needed computer equipment for the Department. Grants from the Ford Foundation, GE and private donors continued to support a wide array of activities.

PROGRAM HIGHLIGHTS

Next year's entering class of 25 Ph.D. students will include 12 international students (several of whom have undergraduate degrees from U.S. universities) and 6 women (24%). Nineteen percent of our entering class have National Science Foundation Fellowships to begin their graduate studies in economics.

Undergraduate enrollment increased slightly again this year. The department has experienced a continued increase in enrollment for undergraduates with a total increase of 46% over the last ten years. There were 132 undergraduate majors in economics (43 of whom are double majors), 124 undergraduate minors and 320 concentrations completed in economics.

Our Class of 1997 job market candidates did very well this year, with 33% receiving assistant professorships in top ten economics departments and business schools. A total of 52% of our graduates accepted academic positions, 11% accepted government positions, 22% obtained positions in the private sector and 15% took positions in non-profit research institutions.

RESEARCH ACHIEVEMENTS

Faculty research continues to be intense and highly productive: Professor Acemoglu has the paper, "Was Prometheus Unbound by Chance? Risk, Diversification and Growth," forthcoming in the *Journal of Political Economy*. Associate Professor Joshua Angrist has the paper, "Jackknife Instrumental Variables Estimation," forthcoming in the *Journal of Applied Econometrics*. Professor Athey is working on, "Comparative Statistics Under Uncertainty: Single Crossing Properties and Log-Supermodularity." Associate Professor Jushan Bai has the paper, "Testing for and Estimation of Multiple Structural Changes in Linear Models," forthcoming in *Econometrica*. Professor Banerjee has the paper, "A Theory of Misgovernance," forthcoming in the *Quarterly Journal of Economics*. Assistant Professor Andrew Bernard has the paper, "Comparing Apples and Oranges: Productivity Convergence and Measurement Across Industries and Countries," forthcoming in *American Economic Review*. Professor Blanchard recently published two books, *The Economics of Transition* and *Macroeconomics*. Professor Caballero published his paper, "Aggregate Employment Dynamics: Building from Microeconomics," in the *American Economic Review*. Associate Professor Dora Costa has the paper, "Displacing the Family: Union Army Pensions and Elderly Living Arrangements," forthcoming in the *Journal of Political Economy*. Professor Diamond published his paper, "On Money Illusion," in the *Quarterly Journal of Economics*. Professor Dornbusch has the paper, "Brazil's Incomplete Stabilization," forthcoming in the *Brookings Papers*. Professor Ellison has the paper, "Risk Taking by Mutual Funds as a Response to Incentives," forthcoming in the *Journal of Political Economy*. Professor Frank Fisher has the book, *The Economic Theory of Production Prices Indexes*, forthcoming. Professor Gruber has the paper, "Physician Fee Policy and Medicaid Program Costs," forthcoming in the *Journal of Human Resources*. Professor Harris is working on a book, *The Economics of Health and Medical Care: A Textbook*. Professor Jerry Hausman has the paper, "The Effect of Superstars in the NBA: Economic Value and Policy," forthcoming in the *Journal of Labor Economics*. Professor Holmstrom has the paper, "Public and Private Supply of Liquidity," forthcoming in the *Journal of Political Economy*. Professor Kremer has the paper, "AIDS, Behavioral Choice, and the Composition of the Pool of Available Partners," forthcoming in the book, *Advance in Mathematical Population Dynamics: Molecules, Cells, and Man*. Professor Paul Krugman published his paper, "Seeking the Rule of the Waves," in *Foreign Affairs*. Professor Paul Joskow has the paper, "The Political Economy of Market-Based Environmental Policy: The 1990 U.S. Acid Rain Program," forthcoming in the *Journal of Law and Economics*. Professor Whitney Newey has the paper, "Convergence Rates and Asymptotic Normality for Series Estimators," forthcoming in the *Journal of Econometrics*. Professor Michael Piore has the paper, "Living with Ambiguity: An Interpretive Approach to New Product Development," forthcoming in the *Harvard Business Review*. Professor Pischke published the paper, "The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure Too?" in the *Quarterly Journal of Economics*. Professor Poterba published his paper, "Distributional Effects of Adopting a National Retail Sales Tax," in the book he edited, *Tax Policy and the Economy, Volume 11*. Professor Nancy Rose has the paper, "Diversification and Executive Compensation: Ability Premia or Managerial Entrenchment?" forthcoming in the *RAND Journal of Economics*. Professor Smith has the paper, "Social Learning in a Changing World," forthcoming in *Economic Theory*. Assistant Professor David Spector is working on "Incomplete

Credit Contracts and Information Production." Professor Peter Temin has the paper, "The Golden Age of European Growth: A Review Essay," forthcoming in the *European Review of Economic History*. Professor Ventura published his paper, "Growth and Interdependence," in the *Quarterly Journal of Economics*. Assistant Professor Robin Wells is working on "Time and Surplus Allocation Within the Marriage." Professor William Wheaton has the paper, "The Cyclic Behavior of the U.S. Lodging Industry," forthcoming in *Real Estate Economics*.

PERSONNEL

Professor Krugman rejoined the faculty as Ford Professor of International Economics after spending two years at Stanford. Professors Spector and Wells joined the faculty as Assistant Professors. Professors Gruber and Ellison were granted tenure and promoted to the rank of Professor. Professors Bai, Costa, and Acemoglu were promoted to the rank of Associate Professor (without tenure). Professor Holmstrom was named the Paul A. Samuelson Professor. Professor Athey was appointed to the Castle Krob Career Development Chair. Professor Acemoglu was appointed to the Pentti Kouri Career Development Chair. Professor Costa was appointed to the Ford Career Development Chair.

Guido Kuersteiner will join the faculty as an Assistant Professor effective July 1, 1997. He received his Ph.D. from Yale University and is a time series econometrician with interests in macroeconomics and finance.

Assistant Professor Alberto Bisin and Associate Professor Thomas Piketty resigned effective July 1, 1997. Professor Bernard's appointment came to an end on June 30, 1997. Professor Bisin will assume a position as Assistant Professor in the Department of Economics at N.Y.U. and Professor Bernard has been appointed as Associate Professor in the School of Management at Yale.

Professor Stanley Fischer remains on leave as First Deputy Director of the International Monetary Fund.

There were three visiting faculty for all or part of the 1996-97 academic year. Professor Jean Tirole, of the University of Toulouse, taught a topics course in industrial organization. Associate Professor Mohamad Hammour taught macroeconomic theory. Assistant Professor Sara Ellison taught statistics and econometrics.

The Department maintains its concern with increasing the representation of women and minorities in the economics profession. All search committees have been instructed to make a special effort to identify outstanding women and minority candidates as an integral component of their search process. As part of the regular recruitment process for junior faculty, the Department solicited/received 186 CVs. After the first screening, 57 files were retained for a more intensive review. After a second screening, 30 candidates (4 of whom were women) were selected for interviews. All candidates were interviewed by at least two members of the faculty. Subsequently, 3 candidates were invited to come to MIT and present a seminar. As a result of this exhaustive process, one offer was made and accepted.

FUTURE PLANS

We must continue to rebuild the faculty. We have made two of the three senior appointments authorized by the Dean and the Provost. We have a search committee reviewing candidates for the third position and hope to make an appointment next year. Almost 45% of the Department is now made up of junior faculty. This situation presents us with opportunities to bring fine new scholars into the senior ranks of the department. It also places an enormous mentoring burden on the active senior faculty in the Department. Providing competitive compensation arrangements and research funding continues to be a major challenge for retaining and attracting the best faculty.

We must maintain the strength of our graduate program. MIT is widely known to have the best Ph.D. program in the world. With the loss of several senior faculty a few years ago, our ability to recruit the best graduate students slipped for a year. We had an excellent yield of the best graduate students applying for admission in AY 96-97 and AY 97-98. The end of the EB pool, the end of the Javits Fellowship Program, and a declining number of NSF fellowships presents a very difficult financial challenge to sustaining our graduate program.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/economics/www/>

Paul L. Joskow

ANTHROPOLOGY

With the 1996-97 academic year, the Anthropology Program has finished its first full year as a department of cultural anthropology. Our new curriculum, now largely in place, emphasizes the contemporary world, in both urban and rural societies, and technology and technical change in social context. Enrollments remain strong, at 483 for the year, as do concentrations, and we currently have an unusually impressive group of minors and majors. We look forward to our move to new quarters in the winter or early Spring of 1998.

PROGRAM CONTRIBUTORS

Program members served on the committee on the First Year; Faculty Policy Committee; HASS-D overview committee; McMillan-Stewart Search Committee, MIT Faculty Newsletter board, and the STS Steering and Admission Committees.

Professors James Howe and Jean Jackson continue to participate in teaching and administration and the Ph.D. Program in the History and Social Study of Science and Technology, as do Associate Professor Hugh Gusterson, who has a joint appointment with the Program in Science, Technology and Society (STS), and Professor Michael Fischer, who is STS Program Head. Professor Arthur Steinberg continues to direct the Integrated Studies Program.

The Seminar series, "Peoples and States: Ethnic Identity and Conflict," which is co-sponsored by the Center for International Studies (CIS) and the Anthropology Program, finished an eighth successful year.

RESEARCH AND PUBLICATION

The book projects of Program members cover a wide range of topics, from weapons labs to Renaissance Venice. Professor Gusterson's Nuclear Rites: A Weapons Laboratory at the End of the Cold War was brought out in 1996 by the University of California Press. Professor Jackson is considering publisher's offers for her recently completed Camp Pain: Building Community and Rebuilding Self in a Chronic Pain Center. Professor Howe's book, A People Who Would Not Kneel: Panama, the United States, and the San Blas Kuna, will be published by the Smithsonian Press in 1998. Professor Steinberg has recently completed his experimental historical novel, The Contarini Journal, co-authored with Oded Asherie, and Professor Martin Diskin's book manuscript on agrarian reform in El Salvador is being edited.

Program members also published a number of articles and book chapters, including Professor Gusterson's "Nuclear Weapons Testing: Scientific Experiment as Political Ritual," (in Naked Science: Anthropological Inquiries into Boundaries, Power and Knowledge); "Remembering Hiroshima at a Nuclear Weapons Laboratory," (in Living with the Bomb: American and Japanese Cultural Conflicts in the Nuclear Age); and "Studying Up Revisited," (Political and Legal Anthropology Review). Professor Diskin published "Distilled Conclusion: the Disappearance of the Agrarian Question in El Salvador," (Latin American Research Review). Professor Howe's "Star Girls and Star Man: A Comparative Analysis of Paired Kuna Myths" appeared in the Journal of Latin American Lore. Professor Jackson published "Coping with Dilemmas of Affinity and Female Sexuality: Male Rebirth in the Central Northwest Amazon (in Denying Biology: Essays of Pseudo-Procreation); "Hippocrates in the Bush," (Anthropological Quarterly); and "The Impact of Recent National Legislation on Tukanoan Communities on the Vaupés Region of Southeastern Colombia" (Journal of Latin American Anthropology).

Program members offered numerous seminar presentations and invited lectures in 1996-97. Professor Howe has completed the first phase of microfilming a tribal archive of historical documents in Panama; he is also actively contributing to a special exhibit on the Kuna of Panama to appear in 1997 at UCLA's Fowler Museum and in 1998 at the National Museum of the American Indian.

James Howe

FOREIGN LANGUAGES AND LITERATURES

Foreign Languages and Literatures (FLL) 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 an MIT education. During the academic year 1997-98, FLL 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 excellence in education within the Institute. Several members of the section were recognized by colleagues in their fields and educational institutions. Bernd Widdig, Associate Professor of German Studies and Director of the MISTI-MIT Germany program, was honored with the 1997 Levitan Prize in the Humanities for his proposal "Daily Explosions: Culture and Inflation in Weimar Germany" making him the third FLL faculty member in four years who has won this distinguished prize. This spring, Takako Aikawa, Assistant Professor of Japanese, was awarded the Mitsui Career Development Professorship which recognizes faculty achievement and encourages cultural and technological exchange between the United States and Japan. Isabelle de Courtivron, Professor of French Studies, was on leave during the fall and spring semesters.

FLL faculty and lecturers have, over the last few years, been actively developing materials and new technology to enhance the teaching of foreign languages and culture. This year saw the completion of four FLL projects. *Star Festival*, an interactive CD-ROM for Japanese language and culture learning (Shigeru Miyagawa, Professor of Linguistics and Japanese, Principal Investigator (PI)) was completed in October. *Dans le Quartier de Paris*, a French language learning interactive program (Gilberte Furstenberg, Senior Lecturer in French, PI) was completed as well as reformatted as a CD-ROM. Margery Resnick, Associate Professor of Spanish, and Margarita Ribas Groeger, Lecturer in Spanish, completed their curriculum development project for Spanish IV called "Crossroads: The Integration of the Teaching of Spanish Language and Culture through Technology" which was funded by the Class of '51 Fund for Excellence in Education/Class of '55 Fund for Excellence in Teaching; and *Paradoja*, a CD-ROM that explores the problems and obstacles women face in Latin America (Lecturer Ribas Groeger, PI) was completed this year as well. Other interactive multimedia projects continue to be developed and expanded, including *No recuerdo*, an interactive narrative documentary for the Spanish language (Douglas Morgenstern, Senior Lecturer in Spanish, PI); *Berliner sehen*, an interactive documentary for German language learning (Ellen Crocker, Lecturer in German, and Research Associate Kurt Fendt, co-PI's); and Shoggy Waryn, Lecturer in French, continues work on his project "Reel Words," an interactive sub-titling program for laserdiscs. Other projects include a special proposal for the teaching of technical Japanese, for which Professor Miyagawa secured generous funding from the MIT Japan program. Lecturers Furstenberg and Waryn's proposal "A Multimedia/Hypermedia Cross-Cultural Project for CD-ROM and the WEB" received a grant from the National Endowment for the Humanities. The Consortium for Language Teaching and Learning remains a strong supporter of various FLL projects, having provided new funding to Monika Totten, Lecturer in German, for the development of a web-based prototype of her project "Surviving the Holocaust: Interviews with German-Jewish Women Writers." The Consortium also provided a grant for "A Web-Mediated Cross-Cultural Project," an archive of French cultural materials being developed by Senior Lecturer Furstenberg and Lecturers Waryn and Sabine Levet, as well as for Lecturer Yoshimi Nagaya's proposal for "Computer Assisted Exercises for Communication in Japanese Language." In addition, Fujitsu Limited provided strong support for Professor Miyagawa's "Japanese-English Lexicon Project: Research and Application of Lexical Structures for Linguistics, Machine Translation and Japanese Language Education." Professor Widdig was instrumental in securing three years of funding for the MISTI/MIT-Germany program from the German Federal Ministry of Research, Science, Technology and Education. Jane Dunphy, Lecturer in ESL received funding from the Class of '51 Fund for Excellence in Education/Class of '55 Fund for Excellence in Teaching for her proposal "English as a Second Language Teacher Assistant Training." Lastly, the Language Learning and Resource Center (LLARC) received a generous grant from the Arthur Vining Davis Foundations for its upcoming expansion and relocation.

Research in the areas of literary and cultural studies, linguistics and language pedagogy continues to be of the highest caliber, with articles published in internationally respected journals. Suzanne Flynn, Professor of Linguistics and Second Language Acquisition and the head of FLL had her article "Second Language Acquisition: Theoretical and Experimental Issues in Contemporary Research" published in *Brain and Behavior Sciences*, and her article "A Parameter Setting Approach to Second Language Acquisition" was published in the *Handbook of Language Acquisition*. Professor Flynn has also received a contract from Blackwell Publishers to launch a new electronic journal in Syntax. Elizabeth Garrels, Associate Professor of Hispanic Studies, had her article "Sobre indios,

afroamericanos y los racismos de Sarmiento” published in the *Revista Iberoamericana*. Professor Miyagawa’s article “Against Optional Scrambling” appeared in *Linguistic Inquiry* and “Word Order Constraints and Non Configurationality” appeared in the *Proceedings of Formal Approaches to Japanese Linguistics, MIT Working Papers in Linguistics*. Professor Widdig authored a chapter entitled “Ein herber Kultus des Männlichen’: Männerbünde um 1900” which appeared in *Wann ist der Mann ein Mann? Theoretische und Historische Perspektiven der Männlichkeit*. Reviews by faculty members appeared in a number of journals, including the *New York Times Book Review*, and *German Quarterly*.

This year FLL sponsored two distinguished visiting professors: Professor Flynn was instrumental in bringing Barbara Lust, Professor of Linguistics and Cognitive Science at Cornell to MIT on the National Science Foundation’s Visiting Professorship for Women in Science Institute award; and Professor Widdig organized the visit of Turkish-German writer Zafer Senocak, the first Max Kade Distinguished Visitor in German Studies at MIT.

FLL faculty were invited to several national and international conferences. Among them, Professor Flynn presented a paper at the Chicago Linguistics Society and was an invited colloquium speaker at the Department of Linguistics at the University of Delaware and at the EUROSLA (European Second Language Society) conference in Barcelona. Senior Lecturer Furstenberg was invited to Harvard University for the NECUSE Symposium on Technology and Education (the New England Consortium for Undergraduate Science Education) to present “In Search of Effective Electronic Tools for Language Learning: Is Interactive Multimedia the Answer?” She also collaborated with Lecturer Crocker and Research Associate Fendt at the CALICO conference (Computer Assisted Language Instruction Consortium) in New York for a talk entitled “Multimedia as an Interactive Narrative Environment for Learning.” Professor Miyagawa was the keynote speaker at the Technology and Japanese Language Conference in Amherst, MA, as well as at the Asian Business Language Workshop held at Brigham and Young University. Professor Miyagawa was also invited to speak at the 20th Anniversary of the Tokyo MIT-ILP office, giving a talk entitled “Will Cyberspace Revolutionize Education?” Professor Resnick presented her talk “Spanish Women as Writers/Observers--Testimonies of the Franco Era” at Northeastern University. Lecturer Totten was invited to present her work-in-progress about survivors of the Holocaust at Inter Naciones (the cultural division of the office for foreign relations) in Bonn, Germany and at the Fritz Bauer Institut in Frankfurt. Nicolás Wey-Gómez, Assistant Professor of Hispanic Studies presented his paper “Los incas, filosofos naturales: La cosmología escolástica en los Comentarios reales del Inca Garcilaso de la Vega” at the Latin American Studies Association (LASA) XX International Congress in Guadalajara, Mexico. Senior Lecturers Furstenberg and Morgenstern were invited to speak at the October MLA in San Juan and co-presented their paper entitled “Virtual Worlds, Real Learners.” Tomoko Graham, Lecturer in Japanese, gave a paper at the 1996 NFLRC Symposium on Technologies and Less Commonly Taught Languages held at the University of Hawaii, and collaborated with Lecturer Nagaya on a paper they presented at the Workshop on Teaching Japanese for the Twenty-First Century held at the University of Washington. Faculty members also gave talks at Boston University, Wellesley College, and the Intel Corporation, among other institutions.

There have been a number of cultural and educational events that our faculty have planned and participated in at MIT and around the Boston area. Edward Baron Turk, Professor of Film and French Studies, presided at a five-film homage to Marcel Carné at the French Library in Boston. Lecturer Totten coordinated a reading and a five-college lecture tour for Inge Deutschkron, one of the German-Jewish writers featured in her “Surviving the Holocaust” project. The German Language Program sponsored a poetry reading by Zafer Senocak, the Max Kade Visiting Professor, as well as the first annual MIT-Lufthansa Award Ceremony for an MIT German language student. Professor Flynn was invited to teach a course on theoretical second language acquisition at the Linguistic Society of America’s Summer Institute at Cornell. Lecturer Waryn organized the AATF (American Association of Teachers of French) annual meeting at MIT. Professor Wey-Gómez received support from the Committee on Race Relations to sponsor a talk by Professor María Antonia Garces. The release of Professor Miyagawa’s *Star Festival* CD-ROM coincided with an FLL/MIT Office of the Arts sponsored visit by Mr. George Takei, artist-in-residence at MIT from October 20-23, 1996. Mr. Takei, best known for his work on *Star Trek*, provided the voice-over narrative for *Star Festival*. His visit was highlighted by a panel discussion entitled “Racism in the Arts” and a public appearance at Kresge Auditorium at which Mr. Takei spoke about his experience in an American WWII internment camp. Professor Miyagawa also collaborated with the Office of the Arts and the Music and Theater Arts Section to bring the Hakubi Kimono School to MIT for a series of Kimono fashion shows featuring both experienced Kimono models and MIT students.

Members of the FLL faculty also contribute to MIT through their service on a number of Institute-wide committees: The Institute Nominations Committee, the Equal Opportunity Committee, the Burchard Scholars, the HASS-D Overview Committee, the Edgerton Award Committee, the Ford Foundation Proposal Committee, the Committee on Corporate Relations, the Arts Council Advisory Committee, the Committee on the Writing Requirement, the Women's Studies Steering Committee, the Phi Beta Kappa Selection Committee, the Corporation's Joint Advisory Committee on Institute-Wide Affairs, the Committee on Academic Performance, Sub-Committees for Undergraduate Programs and the Committee on Curricula, among others.

FLL has maintained its commitment to making full-time appointments and to attracting qualified candidates from minority groups. In order to achieve these goals, FLL has targeted historically black colleges and universities and has advertised in journals focusing on the minority community.

While the number of majors in FLL remains low at two, the number of minors (85) has been steadily increasing and the number of concentrators (455) has remained relatively stable. Spanish continues to have the largest enrollments at 481; followed by French, 361; English as a Second Language, 332; Japanese, 310; Chinese, 225; German, 212; and Russian (Literature), 23. 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. FLL subjects also make up an important component of the Regional Minors Program. There are currently 22 students who are pursuing minors in one of the Regional Studies programs.

MIT alumni have continued their support and efforts to expand the East Asian language program. In response to overwhelming interest in East Asian languages and cultures, the section has recruited Dr. Julian Wheatley, Director of the Chinese language programs at Cornell University, to head the FLL Chinese Program. It is anticipated that the program will continue to expand and that an assistant professor of Chinese Studies will join the section by AY 1999.

More information about FLL can be found on the World Wide Web at the following URL: <http://web.mit.edu/fl>

Suzanne Flynn

HISTORY

Emeritus Professor Thomas H. D. Mahoney died suddenly on April 21, 1997, at the age of 83, while returning from a trip to Seoul, Korea, where he addressed a conference of the Interparliamentary Union. An expert on the eighteenth-century British statesman Edmund Burke, he was the author of *Edmund Burke and Ireland* and the textbook *The United States in World History*. After his retirement from MIT in 1984, he became an important advocate for the welfare of the elderly, and served as Massachusetts Secretary of Elderly Affairs. His colleagues at MIT offer their condolences to his family and friends.

RESEARCH AND PUBLICATIONS

Three members of the History Faculty completed major books after many years of work. William R. Kenan, Jr. Professor Pauline Maier published *American Scripture: The Declaration of Independence* in June, 1997. It has received a great deal of attention from news media for its provocative reinterpretation of the origins of this foundational political document. Associate Professor Jon E. (Ted) Lendon published *Empire of Honor: The Art of Government in the Roman World*, and an article, "Spartan Honor" in *Polis and Polemos*. Assistant Professor Heather Cox Richardson published *The Greatest Nation of the Earth: Republican Economic Policies during the Civil War*. Professor Bruce Mazlish published "Psychohistory and the Question of Global Identity" in *The Psychohistory Review*. Professor Peter C. Perdue published "Military Mobilization in Seventeenth and Eighteenth-Century China, Russia, and Mongolia" in *Modern Asian Studies*, and Lecturer Jinhua Emma Teng published "The Construction of the Traditional Chinese Woman in the Western Academy: A Critical Review" in *Signs: Journal of Women in Culture and Society*.

PERSONNEL

After an extensive national search, the History Faculty hired two new European historians. Assistant Professor Jeffrey Ravel works on the politics of theater in eighteenth-century France. Effective July 1, 1997, he will teach courses on early modern and modern Europe, and on Latin America. Assistant Professor Lora Wildenthal has published several articles on German women in the colonial territories in the late nineteenth and early twentieth centuries. Effective July 1, 1998, she will teach subjects related to race, gender and modern German history. Professor Maier continues as the Affirmative Action Officer. The department continues to search for target of opportunity appointments in all fields, but particularly in African and African-American history.

ACADEMIC PROGRAMS

Associate Professor Christian Appy; Professors Maier, Mazlish, Perdue, Richardson, Arthur J. Conner Professor Harriet Ritvo and Associate Professor Elizabeth Wood participated in the joint Ph.D. program in the History and Social Study of Science and Technology, by teaching graduate seminars, supervising general exams, or conducting tutorials. Professor John W. Dower and Dean of the School of Humanities and Social Science, Professor Philip S. Khoury advised advanced graduate students at Harvard in Japanese and Middle Eastern history, respectively.

Enrollments in history courses were 331 in Fall, 1996 and 464 in Spring, 1997. Three students majored and thirteen students minored in history. The most popular subjects included: 21H102 Emergence of Modern America (32), 21H132 The Vietnam War (35), the ever popular 21H301 Ancient World: Greece (61), and 21H302 Ancient World: Rome (80), 21H433 The Age of Reason (35), 21H502 Revolution in China (26), 21H467J Soviet Politics and Society (30). A new course, "Downtown", by Professor Robert Fogelson, attracted 31 students.

Dean Khoury and Mr. Warren Seamans led freshman advisor seminars on "Conflict and Peace in the Contemporary Middle East" and "MIT: Have You Truly Found Paradise", respectively. Associate Professor Anne McCants supervised UROP projects.

Two students wrote senior theses in History: Jacobo Orenstein-Cardona, on "U.S. Territorial Policy Toward Puerto Rico and the Philippines from 1898 to 1917", and Daniel Socoloff, on "Britain's Crimean Experiment: Foreign War as an Agent of Domestic Reform".

HONORS AND AWARDS

Jacobo Orenstein-Cardona won the Truman Fellowship, a nationally competitive award that provides for support for students interested in careers in public service. He plans to return to his native Puerto Rico to teach chemistry before continuing with graduate work in education and law.

Professors McCants and Ritvo won an award from the Class of '51 Fund for Excellence in Education and the Class of '55 Fund for Excellence in Teaching for their project "History at the Bench: Reading and Writing about Modern Europe".

Dean Khoury was elected President of the Middle East Studies Association of North America and will assume office in fall 1997.

INSTITUTE COMMITTEES AND SERVICE

Professor Appy served on the HASS-D Overview Committee and the Committee on Curricula; Professor Richardson served on the Committee on the Writing Requirement; Professor Ritvo served on the Committees on Nominations, the Freshman Program, and chaired the Search Committee for a new Director of the MIT Museum. Professor McCants served on the Committee on the Undergraduate Program Faculty Working Group on Residence/Orientation, the CUP Subcommittee on Freshman Advising, and chaired the Truman Fellowship Committee.

OTHER ACTIVITIES

The History Faculty established a new HASS concentration, "Studies in the Constitutional Tradition", with generous support from alumnus James Benenson. It provides a framework for investigating the origins and development of constitutional government in America, from the Ancient republics to the Founding Fathers. Professor Richardson directed the Kenan Sahin lecture series, which presented talks on "Finding Amos Webber: Black Life in the Nineteenth-Century North" by Professor of American History Nick Salvatore of Cornell University and "The Problem of Female Patriotism: Post-Civil War America" by Associate Professor Nina Silber of Boston University. Professor Mazlish again jointly ran the History and Literature Workshop series, and Dean Khoury directed the Bustani Seminar of Middle Eastern Studies. During IAP, Lecturer Moshe Gershovich organized a series of films and discussions entitled "Thinking Historically". Professors Wood and McCants participated in the Interdisciplinary Methodology Seminar supported by the Center for International Studies for advanced training of graduate students in Political Science.

More information about the History Faculty can be found on the World Wide Web at the following URL:
<http://web.mit.edu/history/www/>

Peter C. Perdue

LITERATURE

1996-97 was a productive and exciting year for the Literature Faculty. There were several faculty retirements and a successful search for a junior position. Professor Stephen Tapscott published two books, *Twentieth Century Latin American Poetry: A Bilingual Anthology* (University of Texas Press) and *From the Book of Changes* (poetry: Carcanet Press). Professors David Thorburn and Henry Jenkins were awarded a major grant from the John and Mary Markle Foundation for the *Media in Transition* project, and Class of 1956 Associate Professor James Buzard was appointed Fellow of the National Humanities Center.

ACADEMIC PROGRAM AND STUDENT ENROLLMENT

During the past year, 1,048 students enrolled in Literature subjects, 18 were registered as Literature majors, 31 as minors, and 109 as concentrators in Literature for the HASS requirement. In addition, 11 students enrolled as majors in the Film and Media Studies major department. Planning continues toward graduate studies in this area, and this year a new undergraduate HASS-D subject, 21L015 Introduction to Media Studies, was offered for the first time. This subject, co-taught by Professor Jenkins and Assistant Professor Martin Roberts (Foreign Languages and Literatures), draws on guest lecturers from Literature, Foreign Languages and Literatures, Writing, Architecture, Music and other disciplines and covers all media from manuscript and early printed books to electronic technologies of communication, emphasizing the historical and comparative dimensions of the digital revolution.

RESEARCH AND PUBLICATION

Professor Peter Donaldson continues to work on research projects involving archival and educational applications of computer technology to the study of Shakespearean texts and performance, funded by the NEH and the Andrew W. Mellon Foundation. The pilot version of the Shakespeare Electronic Archive was tested at the Folger Shakespeare Library in March, 1997. Professor Alvin Kibel is conducting research on literature and ethics, including environmental ethics, and on *fin de siècle* responses to technology. Professor Thorburn is continuing research on prime time television narrative of the 70s and 80s. Professor Ruth Perry is completing her book on the family in eighteenth century English literature and published several essays on the institutional history of Women's Studies as well as reviews in *Eighteenth Century Fiction*, *Modern Language Quarterly*, and *The Boston Globe*. Professor John Hildebidle published seven new poems, completed a book of poems entitled *Defining Absence* and continues research on the Irish literary group known as Field Day. Professor Stephen Tapscott published his monumental anthology of twentieth-century Latin American poetry this year, as well as a volume of poems, *From the Book of Changes*. Individual poems by Professor Tapscott were published in the *Atlantic Monthly* and reprinted in the *Anthology of Magazine Verse and Yearbook of American Poetry*, *The Norton Book of Love Poems* and elsewhere. He is also translating the poetry of the recent Nobel Laureate Wislawa Szymborska, and selections from his translations of Neruda sonnets were published in *Poems by Pablo Neruda from the Film 'Il Postino'* with a compact disc with the poems read by Sting and Julia Roberts. Professor Jenkins published essays on Buster Keaton, teaching media studies and children's culture in the 1950s, and continues work on a book-length study of childhood in post-War American literature, film and media. Work continues under NEH funding for his CD-ROM film textbook, *The Virtual Screening Room*, and on four anthologies -- on popular culture, cultural studies, children's culture and video and electronic games. Associate Professor Mary Fuller published a study of Derek Walcott's poetry in *Connotations* and is working on a second book on the literature of English travel and exploration in the sixteenth century. Professor Buzard published an article on Henry James in a special issue of *LIT: Literature, Interpretation, Theory* devoted to travel literature, and continues work on his second book, a study of the "autoethnographic" impulse in nineteenth century British fiction. Associate Professor Diana Henderson completed six articles accepted for publication, including work on Shakespeare on film, Renaissance lyric, theater and domestic culture, Virginia Woolf and teaching the Renaissance lyric. Assistant Professor Shankar Raman is completing *Looking East: India in the Renaissance* and published an article on Christopher Marlowe in *Deutsche Vierteljahrsschrift*.

CONFERENCES AND INVITED ADDRESSES

Professor Fuller gave the address at the 150th Anniversary Celebration of the Hakluyt Society, held at the John Carter Brown Library in Providence, and Professor Tapscott gave the keynote address at the Eastern European Conference on British and American Studies in Romania. Professor Jenkins gave the plenary address on "The Future of Media Studies" at the annual meeting of the Society for Cinema Studies. Members of the faculty have also presented their work at meetings of the American Historical Association, the Shakespeare Association of America, Society for Cinema Studies, The Modern Language Association, *Console-ing Passions: Feminism and Television*

Conference, Society for Animation Studies, The International Association for Irish Literature, the American Conference on Irish Studies, Society for the Study of Narrative Literature, the Northeast Victorian Society of America, American Society for Eighteenth Century Studies, the Rocky Mountain Medieval and Renaissance Society, and the Group for Early Modern Cultural Studies. Literature faculty have also delivered public lectures and presentations at Wilfrid Laurier University (Ontario), University of Utrecht (Netherlands), University of Aberystwyth (Wales), University of Denmark at Odense, City University of New York, Harvard University, Arizona State University, Pennsylvania State University, Royal Holloway Collge (London), University of Virginia, Hastings College, Nebraska and Rhode Island College.

SERVICE, GRANTS AND AWARDS

Professor Perry serves as Head of the MIT Women's Studies Program as well as Chair of the Radcliffe Graduate Consortium in Women's Studies, and was elected second vice-president of the American Society for Eighteenth Century Studies. Professor Jenkins serves as Director of Film and Media Studies at MIT. Professor Thorburn is Chair of the MIT Communications Forum. This year, Professors Thorburn and Jenkins were awarded a \$450,000 grant from the John and Mary Markle Foundation for a two-year series of conferences and symposia on the topic Media in Transition. Professor Tapscott was appointed artist in residence at the Virginia Center for the Creative Arts. Professor Buzard was elected Fellow of the Institute for Advanced Study for 1997-8 (declined) and Fellow of the National Humanities Institute in Research Triangle Park, N.C. for the same period. Professor Henderson received the Jephtha H. and Emily V. Wade Award and the Old Dominion Fellowship for Fall, 1997. Professor Raman was appointed Research Fellow at the University of Konstanz for 1997-98, and also received an Old Dominion Fellowship.

PERSONNEL

Professors Irene Tayler and Travis Merritt retired this year, and Christina Klein was appointed to an initial three year position as Assistant Professor to begin July, 1997. Professor Jenkins was promoted to Professor and Associate Professor Mary Fuller was promoted to tenure, both promotions effective July 1, 1997.

AFFIRMATIVE ACTION

This year's search resulted in the addition of Christina Klein as Assistant Professor of Literature to begin July 1, 1997. With the retirement of Professor Tayler, the number of women at faculty rank remains at four. With the promotion of Professor Fuller to tenure, the number of tenured women remains at two. The faculty now includes one Asian scholar, and it is expected that ongoing searches and vigorous recruiting efforts will result in the adppointment of an additional woman and a minority scholar over the next two years.

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 in their integrity. The social and moral contexts of human experience also informs all our curricular and co-curricular offerings. Faculty and teaching staff help students understand art's particular demand for rigor and discipline, 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 serves as a base for those who have the talent and desire to continue their education in Music or Theater beyond the undergraduate level. The Section also affirms its commitment to diversity within its disciplines and among its staff.

HIGHLIGHTS OF THE YEAR

The year began with Professor Peter Child taking over as Section head for a three year term. Assistant Professor Janet Sonenberg became Director of Theater Arts, a position she began as Acting Director the previous semester when Professor Alan Brody became Associate Provost for the Arts. October saw a performance of the dramatic oratorio *Reckoning Time: A Song of Walt Whitman*, with music by Professor Child, libretto by Professor Brody and conducted by Senior Lecturer John Oliver. The performance was in honor of Senior Lecturer Oliver upon his retirement from MIT. In December Music and Theater Arts hosted a successful visit by the Corporation Visiting Committee. December also saw the first performance of MITCAN, the MIT African Performance Ensemble, under the direction of Assistant Professor James Makubuya. In February the Sections new Harpsichord, from the premier builder Eric Herz, was officially dedicated in Killian Hall with the premier performance of *things that flow*, a work by Christopher Adler, MIT '94. The Endellion String Quartet, in residency in April of 1995, returned for another successful week of performances and master classes this past April. The chamber ensemble SONOS, comprised of Bayla Keyes, violin; Professor Marcus Thompson, viola; Andrés Díaz, 'cello; and Senior Lecturer David Deveau, piano, continued their collaboration with another well received performance in April.

HONORS AND AWARDS

Professor Ellen Harris received the Class of 1949 Professorship Chair. Professor Lowell Lindgren became a Margaret MacVicar Faculty Fellow at MIT and received the Luise Vosgerchian Teaching Award from Harvard University. Theater Arts Lecturer Michael Ouellette received the Gyorgy Kepes Fellowship Prize for excellence in the creative arts. Grant Ho '97 (Minor in Music and recipient of the Advanced Music Performance Scholarship) received the Louis Sudler prize and Solomon Douglas '97 (Major in Music) received a Wiesner Award.

PROGRAM HIGHLIGHTS

Enrollments in Music subjects dropped slightly this year to 1268 while Theater climbed slightly to 407 for a total of 1673. Thanks to a major gift from Brad and Dorothea Endicott, work is well under way on the renovation of space in the MIT Museum building to accommodate our burgeoning World Music Program. The World Music Room will house our Gamelan and African instrument collection and be a combined rehearsal and performance space for the Gamelan, the African Performance Ensemble (MITCAN) and MITHAS (MIT Heritage of the Arts of Southeast Asia). Funded by the Council for the Arts at MIT an evening of music by Professor and Section Head Peter Child was presented in February featuring performances by three of the Sections Performance Scholarship recipients, Asher Davison, Susan Shi and Grant Ho. The MIT Symphony Orchestra under the direction of Professor Emeritus and Senior Lecturer David Epstein had a noteworthy season of concerts featuring MIT student soloists and the music of MIT student composers.

Theater Arts faculty and visiting scholars were active as directors of major student productions. Scott T. Cummings, Visiting Scholar with Shakespeare and Company, directed *Two Gentlemen of Verona* in October. Lecturer Ouellette directed Shakespeare's *Much Ado about Nothing* with The Dramashop for its IAP production in January. Tina Packer, Visiting Scholar with Shakespeare and Company, directed *The Life and Death of King John* in March. Associate Provost Brody directed Playwrights in Performance in two evenings of one-act plays by MIT student playwrights.

ACHIEVEMENTS

The level of productivity by our faculty remained high. Professor Thompson toured extensively with the Boston Chamber Music Society and performed at numerous festivals in Alaska, Washington, Colorado and New Mexico. Associate Professor Evan Ziporyn premiered his new work *Amok* for 25 piece Balinese Gamelan in April. He also toured with Bang on a Can All-Stars and the Steve Reich Ensemble in Italy, Israel and the U.S. Associate Professor Martin Marks saw publication of his book *Music and the Silent Film: Contexts and Case Studies 1895-1924* by Oxford University Press. Professor Marks also performed his own piano score for the rarely seen Russian film *Nail in the Boot* at the Harvard Film Archive and performed the original piano score for the German silent film *Metropolis* at a seminar on film music in Los Angeles, California. Professor Harris became Associate Editor of *Musical Quarterly*, presented 3 papers at Aston Magna Academy and in May made her solo debut with the Boston Pops Orchestra. Professor Lindgren delivered a paper at the Internationales Wissenschaftliches Kolloquium at the Göttinger, Germany, Händel-Festspiele 1997. Senior Lecturer Deveau had a second successful season as Director of the Rockport Chamber Music Festival. Professor Child was a featured composer at the Computer Arts Festival in Padua, Italy, in April where the Italian new music group Interensemble performed his *Ensemblance* for chamber ensemble with computer generated tape. This coincided with the release of the groups CD recording of Professor Child's work on the Rivoalto label. Institute Professor John Harbison conducted performances of Handel's *L'Allegro* and *Il Penseroso ed il Moderato* with the Mark Morris Dance Company in Los Angeles, California. He conducted at the Dallapiccola Festival at Smith College and a performance with Dawn Upshaw at Carnegie Hall in April. Two new works by Professor Harbison were premiered this year, *Emerson*, with the Cantata Singers in Boston and *Olympic Dances* with the Pilobolus Dance Company in Athens, Georgia. Other works received performances by the Baltimore, Milwaukee and St. Louis Symphony Orchestras. Professor Sonenberg presented a paper at the International Theater University Association Congress in Montreal on Dreamwork Process, the research for her book in progress *Threshold of the Unconscious*. Senior Lecturer Pamela Wood had solo performances with the Concord Choral Society, the Neponset Choral Society and Opera Longy. She was also an adjudicator for the Leontyne Price Vocal Arts Competition at New England Conservatory of Music. Lecturer Mark Harvey saw the release of his third CD *Psalms and Elegies* containing four of his compositions performed by his group the Aardvark Jazz Orchestra.

PERSONNEL

Professor Ziporyn received tenure, Professor Sonenberg was promoted to Associate Professor without tenure and Lecturers George Ruckert and Michael Ouellette were both appointed as Senior Lecturers, all effective on July 1, 1997. Lecturer Elena Ruehr was reappointed for a three year term also effective July 1. Instructor Thomas DeFrantz completed his Ph.D and will be appointed Assistant Professor of Theater Arts July 1. Senior Lecturer Beth Soll leaves the department as of July 1 and will join the faculty of the University of California at Santa Barbara.

More information about Music and Theater Arts can be found on the World Wide Web at the following URL:
<http://mit.edu/mta/www/>

Peter Child

PROGRAM IN WRITING AND HUMANISTIC STUDIES

The Program in Writing and Humanistic Studies is an interdisciplinary program concerned with writing as a means of communication of ideas, a means of creative expression, and a vehicle for exploring the cultural context of science and technology. Each year, approximately 900 undergraduates enroll in our subjects. Some subjects satisfy either Phase One or Phase Two of the Institute Writing Requirement.

In addition to its curriculum, the Program offers a number of cultural and literary activities to the MIT community. The distinguished Austrian writer Gregor von Rezzori was a Writer-in-Residence in November, spoke in our Writers Series, and offered some master writing classes. Poets John Ashbery, William Corbett, W. S. DiPiero, August Kleinzahler, Martha Collins, Carolyne Wright spoke in our Poetry at MIT series.

In research and writing, Professor Kenneth Manning continues to increase and document his large data base on black physicians in his project on "Blacks in American Medicine, 1860-1980". Professor James Paradis continues his work on Samuel Butler. Professor Elóbieta Ettinger Chodakowska continues her biography of Hannah Arendt. Professor Harriet Ritvo has completed her new book, *The Platypus and the Mermaid and Other Figments of the Classifying Imagination*, which will be published by Harvard University Press in October 1997. Professor Cynthia Wolff continues work on slave narratives and primary research for a biography of Willa Cather. Assistant Professor Susanne Klingenstein is making final revisions on her new book, *Enlarging America: The Cultural Work of Jewish Literary Scholars, 1930-1990*, which will be published by Syracuse University Press. Senior Lecturer Edward Barrett continues his work on the *Electronic Multimedia Online Textbook in Engineering* and has begun a new series of books at the MIT Press on digital communication. Writer-in-Residence Pamela Alexander published her collection of poetry, *Inland*, which won the Iowa Poetry Prize. Writer-in-Residence Stephen Alter completed a memoir of his childhood in India, which will be published by Henry Holt. Writer-in-Residence Helen Elaine Lee has completed her new novel *Water Marked*, which will be published by Scribner.

On other activities and honors of the faculty, Professor Wolff has won both a Guggenheim and a National Endowment for the Humanities grant for the next two years. Professor Manning spent the spring semester at the University of North Carolina in an exchange program.

In Institute service, Professor Paradis completed his second year as chair of the HASS-D Committee. Professor Alan Lightman played a significant role in developing a new Undergraduate Communication Requirement, which the Institute faculty voted to explore in its May meeting. Professor Lightman also published an essay in the May Faculty Newsletter titled *MIT Education in the Age of Information*.

In curricular matters, the Program has introduced a new subject, Rhetoric, offered both semesters, and we have appointed a new assistant professor of digital communication, Youngme Moon, whose research centers on the interaction between people and computers. In addition to the Youngme Moon appointment, we have appointed Helen Elaine Lee, a novelist, as assistant professor of writing. Professor Klingenstein will be promoted to associate professor without tenure. The Program has initiated a new national search for an assistant professorship in science writing. Professor Chodakowska retires on June 30th. The headship will be transferred from Professor Lightman to Professor Paradis.

We had 58 percent women on our total staff and 55 percent women in our core faculty. We have three African-Americans in our teaching staff, a lecturer, an assistant professor, and a full professor.

More information about this Program can be found on the World Wide Web at the following URL:
<http://web.mit.edu/humanistic/www>.

Alan Lightman

DEPARTMENT OF LINGUISTICS AND PHILOSOPHY

The Department of Linguistics and Philosophy consists of two sections, twenty-three faculty members (four of them jointly appointed), sixty-four graduate students, two dozen or so visiting scientists and scholars, and a staff of seven. Each section operates quite independently of the other; yet between them there is a significant overlap of intellectual interests in education and research, both among the faculty, the graduate students, and the 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; second and seventh, respectively -- on program effectiveness.

RESEARCH: LINGUISTICS

The linguists continue to pursue an account of natural language in terms of principles of computational economy. The Minimalist Program for linguistic theory, Optimality Theory, and the theory of Distributed Morphology offer somewhat different, sometimes complementary suggestions for the course that the pursuit might follow, and for the reduction of the conceptual apparatus of linguistic theory to virtual conceptual necessity. These ideas continue to be explored, developed, and challenged in research on syntax, semantics, morphology, phonology, and on the interfaces between these modules of the grammar of natural language by MIT graduate students, faculty, and visitors.

Neurolinguistic research, in addition to rapidly developing work on language growth and use, is now a central piece of Linguistics research at MIT, and has led directly to the Mind Articulation Project, a five-year, joint MIT Linguistics/Tokyo University Physiology project supported by the Japan Science and Technology Corporation.

RESEARCH: 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: the philosophy of phonology and morphology; theories of consciousness and the mind-body problem; causation and laws of nature; the 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; the 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 gave -- in the course of the year -- a large number of colloquium presentations, keynote talks at conferences, and workshops in various parts of the United States and the world, while publishing an equally large number of journal articles, chapters in books, and reviews. In addition, the following books appeared during the year: Institute Professor Noam Chomsky's *Powers and Prospects: Reflections on Human Nature and the Social Order* (expanded edition: Allen & Unwin and the South End Press); Professor Irving Singer's *The Harmony of Nature and Spirit* (Johns Hopkins) -- volume three of his *Meaning in Life* trilogy; Assistant Professor Alex Byrne's edited volumes (with Princeton's David Hilbert) *Readings on Color: The Philosophy of Color* and *The Science of Color* (MIT Press).

RECRUITMENT AND PLACEMENT

Recruitment of graduate students to the two programs continues at its usual level. Linguistics received ninety-four applications for fall 1997 admission, over half of them from women. Fourteen of the applicants were offered admission. Eight of the ten who accepted the offer are women, one of them an Asian American woman, with eight of the ten being international students. On the philosophy side of the Department, there were 101 applications, twenty of them from women. Thirteen applicants were offered admission with full financial support, with ten others placed on a waiting list for such support. Eighteen declined the offer and five accepted. Of the five new students, two are women and two are international students.

At the exit end of the doctoral program, the placement of persons completing the doctoral programs continued to be good. Seven graduates of the programs will begin new jobs in the fall: at the University of Chicago, UCLA, the

University of Delaware, Harvard University, the University of Michigan, and two at the University of Massachusetts/Amherst.

HONORS AND AWARDS

Professor Chomsky was awarded the Helmholtz Medal by the Berlin-Brandenburgische Akademie Wissenschaften and an honorary doctorate by the Universidad de Buenos Aires. Ferrari P. Ward Professor Kenneth Hale was awarded an honorary doctorate by the University of Arizona.

LEAVES OF ABSENCE

Professor Alec Marantz was on leave for the academic year, during which time he conducted business as usual in his Building 20 office.

PERSONNEL

It is with pleasure that we note the promotion of Irene Heim to the rank of Professor; the appointment of Professor Robert Stalnaker to the Laurance S. Rockefeller Chair; and the appointment of Assistant Professor Kai von Fintel to the Class of 1942 Career Development Chair. Mid-year, under the Provost's initiative to increase the number of women on the MIT faculty, Sabine Iatridou (MIT Ph.D. 1991) was appointed Associate Professor of Linguistics (with tenure). Michael Glansberg, visiting this year as a temporary replacement for the late Professor George Boolos, will continue in that role as a tenure-track Assistant Professor of Philosophy.

With the appointment of Professor Iatridou, the affirmative-action goal of the Department of several years standing, to increase the representation of women on the faculty to at least four, has been realized. Thus it is time to reset the goal at six and to move ahead on this new goal.

A final personnel addition: On July 2, just out of reach of the present fiscal year, Mary Grenham -- the Administrative Officer of this department -- gave birth to a son, Aran.

Wayne O'Neil

DEPARTMENT OF POLITICAL SCIENCE

The principal goals of the Department of Political Science are to provide a broad-based undergraduate curriculum in political science, while offering graduate education and research training at a level of excellence equal to or superior to that offered by any political science department in the country; to advance understanding of political behavior, processes, and institutions, in both domestic and international contexts, by maintaining an environment in which faculty and advanced students can carry out research of the highest quality; to contribute to the capacity of governmental and private organizations at the local, national, or international level to deal effectively and humanely with the issues they confront; to create a community within the Department of men and women - senior and junior scholars, students, and staff - which is as rich and diverse in terms of gender, race, color, and national origin as can be achieved. The essential task for the future is to pursue these objectives at the highest level of excellence, while striking a proper balance among them. The key to superior performance in all these respects lies in the recruiting, keeping, and nurturing an outstanding faculty and graduate student body.

EDUCATIONAL INITIATIVES

Washington Internship Program: MIT stands in a unique place in American higher education to combine the concerns of science and engineering with public service. 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 designed and administered a summer internship in Washington, DC for MIT students from across all disciplines. The internship's purpose is not to enhance job skills, like many internships, but rather to provide a closer and more realistic look at policymaking than is possible in classroom settings. Students are required to enroll in a new subject that introduces them to the contexts of policymaking. To date, thirty students have been placed in such organizations as: the U.S. Department of Energy - Office of Fossil Energy, the U.S. Department of Commerce - Office of Technical Competitiveness, The White House - Office of Science and Technology, American Enterprise Institute - Economic Policy Division, The Heritage Foundation, and the American Association for World Health. Associate Professor Charles Stewart directs the program and teaches the substance of the spring semester material. That faculty member continues to be responsible for the seminar in the fall, but it is best if the weekly sessions focus on material presented with the help of an invited speaker drawn from the MIT faculty, in the area of that faculty member's expertise. This program allows MIT's technically-oriented students to see up close how institutions vital to their later success operate. And, it gives the federal government and other policymakers early access to the best young scientists and engineers in America. It is a unique contribution to Federal policy by a unique institution of science and engineering.

Asia-Pacific Crisis Simulation: Every second year the Department of Political Science and the MIT Japan Program organize an "Asia-Pacific Political Crisis Simulation." The exercise brings together scholars and practitioners from seven nations in the region, and is the culmination of a graduate seminar entitled "Japan and East Asian Security" taught by Professor Richard Samuels. The principal goal of this exercise is to examine Japan's future international role in light of recent domestic, regional, and global changes and to trace possible paths along which this role might develop over the next dozen years. In addition, careful attention is paid to the foreign policy choices and domestic political dynamics in China, Korea, and the United States. Participants are assigned to teams representing constituencies and leaders from a number of regional actors including Japan, the United States, the People's Republic of China, (a unified) Korea, Indonesia, Taiwan, Vietnam, Malaysia, and Australia. Through role playing and negotiations, each team develops plans and policies over the course of three four-year "moves." A central control team guides the game and plays the role of countries, regions, and other actors not represented by an independent team. Principal players, drawn from among former government officials, business executives, and academics, were assigned roles as key policy makers of each of the country teams. The exercise receives considerable attention in Japan: it was the topic of a three-hour television show in 1995, and of a series of debates in the Japanese Diet in 1997.

New Subjects: Many new subjects were developed this past year on both the graduate and undergraduate level. Assistant Professor Delia Boylan developed two new subjects: "Introduction to Latin American Politics," and "Comparative Political Economy." Assistant Professor Susan Giaimo offered two new subjects: "Comparative Social Policy: Challenges to the Welfare State," and "Comparative Public Policy: The United States and Western

Europe.” Next year, Assistant Professor Melissa Nobles will offer a new subject “Retribution and Reparations” which will examine the various political instruments used to deal with the perpetrators of abuses and their victims after the dissolution of politically repressive regimes. Associate Professor Kenneth Oye established, with Professor Myron Weiner and Associate Stephen Van Evera, a joint Training and Research Program on Transnational Security Issues at the Center for International Studies and the Harvard Center for International Affairs. Professor Barry Posen co-offered, with Professor Harvey Sapolsky, “War on Film,” a popular IAP mini-course. Professor Sapolsky has developed two summer professional institute subjects - one on security studies, the other on innovation - both of which will be offered during the summer session 1997. Assistant Professor Frederic Schaffer offered two new undergraduate subjects: “What is Politics?” and “Introduction to Comparative Politics: Paths of Development.” Assistant Professor Stuart White developed an undergraduate subject, “Liberty,” exploring the nature, value, and legitimate scope of liberty, and a graduate subject, “Normative Political Economy.” He also established the MIT Political Theory Workshop, which draws faculty and student participants from MIT, Tufts University, and Harvard University in the fields of philosophy, political science, and economics. Finally, Assistant Professor David Woodruff offered two new graduate seminars, “Field Seminar in Comparative Politics: Intellectual Origins and Current Trends,” and “Institutional Economics, Intellectual History and Applications to Comparative Politics.”

STUDENT RECRUITMENT, ENROLLMENT, AND PLACEMENT

The Department continues to compete successfully with other major departments in the recruitment of graduate students. We attracted an excellent class of incoming Ph.D. students. Of the 18 students who accepted our offer of admission, nine (50%) are female, and six are international students. The Department will also enroll seven Masters students in September 1997.

Our graduating doctoral students continued to find positions at leading research universities and institutions such as Princeton University, Harvard University, University of Maryland, Rand Corporation, and leading institutions in Europe and Asia.

Undergraduate enrollments went down slightly in 1996-97 to 783 from 808 in 1995-96, while the number of undergraduate majors remained constant at 31. There were 28 minors, and 45 concentrators. Graduate student enrollment for 1996-97 was 123.

FACULTY

Three new Assistant Professors joined the Department effective July 1, 1996. Professor Boylan, from Stanford University, is mainly interested in Comparative Politics and International Relations, especially Latin America. Professor Giaimo, from the University of Wisconsin-Madison, works on German politics, comparative social policy, and health policy. Professor White, from Oxford and Princeton Universities, joined the Department in the field of Political Theory.

Professor Nobles was awarded the Cecil and Ida Green Career Development Professorship. Associate Professor James Snyder, who specializes in American Politics, will be promoted to Full Professor, effective July 1, 1997. Professor Joshua Cohen, who specializes in Political Philosophy, will succeed Professor Samuels as Department Head.

Increasing the presence of minorities and women in the Department remains a major concern. All four search committees made special efforts to identify outstanding women and minority candidates as an integral part of their searches. The Department received and reviewed a total of 383 applications for four open positions. Of those, 91 were women and 10 were minorities. Out of 16 finalists invited to present seminars, 4 were women.

Search committees in the areas of Comparative Politics/Development, American Politics and Public Policy, International Relations/Political Economy, and Comparative Politics/Political Economy have formed and will evaluate potential candidates at both the junior and senior level during the coming academic year.

Faculty research activities include:

- “Campaigns versus Elections,” and with Professor Snyder, “Money and Office: The Sources of the Incumbency Advantage in Congressional Campaign Finance,” “Party Platform Choice in Single-Member District and Party List Systems,” “The Inter-Election Dynamics of Campaign Finance: US House Elections, 1980 to 1994,”

-
- “Valance Politics and Equilibrium in Spatial Election Models,” and “Money, Elections, and Candidate Quality,” (Associate Professor Stephen Ansolabehere)
 - “European Responses to Globalization” (Professor Suzanne Berger)
 - “Central Bank Reform in Transitional Democracies” (Professor Boylan)
 - “Directly Deliberative Polyarchy,” with Visiting Professor Charles Sabel, and “Deliberative Democracy” (Professor Cohen)
 - “Chinese Environmental Policy Implementation in Industry Boiler Sector,” and “Corporate Reform in Chinese State Industry” (Assistant Professor Zhiyuan Cui)
 - “Adapting the Welfare State: The Case of Health Care Reform in Britain, Germany, and the United States” (Professor Giaimo)
 - “Ruling the World: Power Politics and the Rise of Supranational Institutions” (Post-doctoral Research Associate Lloyd Gruber)
 - “Comparison of the Transition from Domestic Reform to War in the Presidencies of Woodrow Wilson (from the New Freedom to World War I), Franklin Roosevelt (from the New Deal to World War II), Harry Truman (from the Fair Deal to the Korean War), and Lyndon Johnson (from the Great Society to the Vietnam War)” (Assistant Professor Daniel Kryder)
 - “Public Sector Reform and Union Participation: The Case of the Italian Pension Reform” and “The End of Solidarity?: the Decline of Equitarian Wage Policies in Italy and Sweden,” both with PhD candidate Lucio Baccaro; “Everything Old is New Again: Organizational Innovation in the American Union Movement,” with PhD candidate Janice Fine (Associate Professor Richard Locke)
 - “Electoral Effects of Campaign Spending,” and “Advertising in the Liquor Market” (Visiting Scholar Jeffrey Milyo)
 - “Shades of Citizenship: Race and Censuses in Modern Politics,” and “Politics of Counting: Race, Ethnicity and Censuses in Modern Politics” (Professor Melissa Nobles)
 - “Underprovision of Compensation,” “Trade and Regulation,” “Regionalization and Trade” and “Environmental Aid and Coal Combustion in China,” with Professor Cui; (Professor Oye)
 - “Innovation in the US Army, 1970-1980,” “Nationalism and War,” and “Armor Breakthrough Operations, 1944” (Professor Posen)
 - “Comparative Political Economic History of Italy and Japan” (Professor Samuels)
 - “The Management of the Cold War - an analysis of the government’s structure and processes,” “The Third Battle of the Atlantic: Anti-submarine Warfare in the Cold War,” “The Changing Structure of the US and European Defense Strategies,” and “The Role of Evidence in Environmental Disputes/Science Policy” (Professor Sapolsky)
 - “Can Freedom be Destroyed? Lessons from the Nazi Death Camps,” “One-sided Diets, False Twins, and Other Pitfalls of Conceptual Reconstruction,” and “Why Don’t Political Scientists Use More Jargon?” (Professor Schaffer)
 - “Estimating Party Influence in Congressional Roll-Call Voting,” “Referendums, Initiatives, and Legislative Partisanship” with PhD candidate Jeffrey Lewis; “The Relationship Between the Legislative Activity of Members of Congress and Interest-Group Campaign Contributions,” and “The Electoral Benefits and Costs to Members of Congress for Supporting or Opposing the President,” both with Associate Professor Ansolabehere; and “The Legislative Connection in Congressional Campaign Finance,” “Formal Models of Spatial Electoral Competition,” and “Measuring the Extent to Which Money Buys Access” (Professor Snyder)
 - “Origin and Development of the Congressional Committee System,” and “Origin and Development of Legislative Careerism in the United States” (Professor Stewart III)
 - “Causes of War” (Professor Van Evera)
 - “The Civic Minimum; on Socio-Economic Rights,” and “Freedom of Association” (Professor White)
 - “Relationship Between State and Market: Building on Post-Socialism” (Professor Woodruff)

Political Science faculty continue to be prolific publishers of books and articles. Here we can list only a few. Professor Ansolabehere co-authored articles that appeared in *American Journal of Political Science*, and *Legislative Studies Quarterly*. He also contributed a chapter in the book *Do the Media Govern?* Sage. Professor Berger wrote (with Richard Lester) the book *Made by Hong Kong*, Oxford University Press. Professor Boylan’s work appeared in *Latin American Research Review*, and she contributed a chapter to the book *Technopols: The Role of Ideas and Leaders in Freeing Politics and Freeing Markets*, Penn State Press. Professor Cui wrote a book *Institutional Innovation and the Second Thought Liberation Movement*, Oxford University Press (in Chinese). He also wrote an

article for the *Journal of International Affairs*. Professor Giaimo co-authored a chapter for the book *Health Policy Reform, National Variations and Globalization*, St. Martin's Press.

Professor Kryder has two books forthcoming: *Divided Arsenal: War Mobilization, the American State and the Management of Race Conflict, 1941-1945*, Cambridge University Press, and *Jim Crow, Ambushed: The June 9, 1943 Black Troop Insurrection at Camp Stewart*, Louisiana State University Press. He also wrote an article that appeared in *Studies in American Political Development*. Professor Locke wrote and co-authored several articles and co-authored a chapter in the book *Negotiating the New Germany*, Cornell University Press. Professor Posen's work appeared in *International Security*, *Security Studies*, and *Strategic Review*. A Japanese edition of Professor Samuels' book *Rich Nation Strong Army* (originally published by Cornell University Press) was published this year. He also co-authored a book chapter *Eagle Eyes the Pacific*.

Professor Sapolsky wrote and co-authored several articles with several graduate students in the MIT Security Studies Program that appeared in the journals *Joint Forces Quarterly*, *International Security*, *Breakthroughs, Issues in Science and Technology*, and *Parameters*. Professor Schaffer's article "Political Concepts in the Study of Democracy: The Case of Demokaraasi in Senegal" appeared in *Political and Legal Anthropology Review*. Professor Snyder published several articles in *Journal of Political Economy*, *Rand Journal of Economics*, *Public Choice*, *Legislative Studies Quarterly*, *Journal of Public Economics*, and *American Political Science Review*. Professor Stewart has an article forthcoming in the *American Journal of Political Science*. Professor Van Evera wrote the *Guide to Methods for Students in Political Science*, Cornell University Press (forthcoming), and had an op-ed published in *The New York Times*. Professor Weiner is co-editor of several forthcoming books, and is the author of two reports: *German and American Migration and Refugee Policies: Recommendations of the Joint German-American Project of the Academy of Arts and Sciences*, Cambridge, MA, and *People on the Move: Lessons from International Migration Policies*, Johannesburg: Center for Development and Enterprise Migration Series. Professor White's articles appeared in *Equality*, a journal published by the Institute of Public Policy Research in London, and in *Political Studies* earlier this year. Professor Woodruff's work entitled "Barter of the Bankrupt: The Politics of Demonetization in Russia's Federal State" will be published in Burawoy and Verdery, eds., *Ethnographies of Transition*.

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. Professor Oye is a Trustee of the World Peace Foundation. Professor Weiner was appointed chair of the newly formed External Research and Advisory Committee of the United Nations High Commissioner for Refugees, Geneva.

Richard J. Samuels

PROGRAM IN SCIENCE, TECHNOLOGY, AND SOCIETY

The 1996-97 academic year marked a transition in leadership: Professor Merritt Roe Smith handed over the Directorship of the Program in Science, Technology, and Society (STS) to Professor Michael M.J. Fischer, and Professor Kenneth Keniston handed over the Directorship of Graduate Studies to Associate Professor Deborah Fitzgerald. Professor Keniston became the Director of Projects, a newly created position to help the Program with outreach, grantsmanship, and raising of money, a capacity in which he has excelled in the past. In September 1996, the faculty held a follow-up to the Faculty Retreat held the previous May. A new Core Course was approved and ran throughout the 1996-97 academic year, involving a majority of the faculty who were in residence, the first year students, half of the second year class, many of the third year students, and one or two of the more advanced students. A review of the undergraduate program is in its initial phases under a committee led by Associate Professor Larry Bucciarelli.

DOCTORAL PROGRAM

In its ninth year, the History and Social Study of Science and Technology (HSSST) Doctoral Program (a collaborative venture of STS, the History Faculty, and the Anthropology Program) continued to develop in a satisfactory way. Present and incoming students received a variety of grants and fellowships, including fellowships from the Dibner Institute, Ida Green, the National Science Foundation (NSF), American Association of University Women, and the Wenner-Gren Foundation. The HSSST Doctoral Program received 67 applications for the 1997-98 academic year. Five of the eight students offered admission to the HSSST Doctoral Program accepted. Important roles in the program were played by Professors Fitzgerald (Director of Graduate Studies; STS), James Howe (Anthropology Program), and Peter Perdue (History Faculty), all of whom were members of the Doctoral Program Steering Committee. As Director of the STS Program, Professor Fischer also served on the Doctoral Program Steering Committee.

The major new initiative in the doctoral program was the launching of a new Core Course (STS.201/202), proposed at the spring 1996 Faculty Retreat, planned over the summer, and approved at the September follow-up meeting. Built around substantive topics ranging from the scientific revolution of the seventeenth century to the molecular biology revolution, the computer revolution, and environmental issues, it is an attempt to bring into juxtaposition the different methods and frameworks of the several disciplines that make up the STS Program, and thereby to work out, by doing, the distinctive ethos of this interdisciplinary program.

PROJECTS, GRANTS, AND INITIATIVES

Assistant Professor David Mindell received a grant of \$13,800 from the James H. Ferry, Jr. Fund (administered by the MIT Research Committee). Funds were awarded to support the development of Mindell's joint STS/Department of Electrical Engineering and Computer Science (EECS) course, "Structure of Engineering Revolutions." Distinguished Visiting Professor Thomas P. Hughes received a grant of \$65,000 from the Sloan Foundation; Hughes will be creating a network of websites on the history of technology. Work continued on the history textbook project, "Integrating the American Past: A New Narrative History of the United States," which is funded by the Alfred P. Sloan Foundation (grant total: \$1.754 million over eight years). The project is headed by Professor Smith and includes Professors Pauline Maier (MIT), Daniel Kevles (California Institute of Technology), and Alex Keyssar (Duke University) as primary authors.

EDUCATIONAL ACTIVITIES

The STS Program offered 25 undergraduate subjects and 21 graduate subjects. Undergraduate enrollments totaled 313 (fall: 124; spring: 189). During the 1996-97 academic year there were 5 majors, 7 minors, and 42 concentrators representing the Classes of 1997 to 2000. On the graduate level, the new two-semester Core Course (STS.201/202, "Introduction to STS") was taught by Professors Fischer and Fitzgerald, with other faculty members participating in various strands of the course.

SPECIAL EVENTS

The 1996 Siegel Prize for the best work by an MIT student in science, technology, and society was won by Ms. Hannah Landecker, a third year doctoral student in HSSST for her paper "Seeking Cellvation™: HeLa Cells and Immortality." The 1997 Annual Arthur Miller Lecturer on Science and Ethics was Dr. George Annas, the Edward R. Uteley Professor and Chair of the Health Law Department and Director of the Law, Medicine and Ethics Program at

Boston University Schools of Medicine and Public Health. Annas' talk, "Cloning the Capitalism Gene: Genism, Patenting, and Privacy," addressed some of the social and political issues raised by cloning. Some 300 people were attracted to a panel discussion on "The Media, the Government, and Scientific Misconduct: The David Baltimore Case in American Political Culture" with Professors David Baltimore (MIT) and Kevles; this was the best attended of the Fall 1996 STS Colloquium series. On May 1, the STS Program hosted a dinner meeting with faculty members from Harvard's History of Science Department. In addition to Professors Fischer (Director of STS) and Peter Galison (Chairman of Harvard's History of Science Department), ten STS faculty members and five Harvard History of Science faculty members attended this dinner. Professor Fischer organized this dinner to give the faculty of both groups the opportunity to meet and discuss ways in which both organizations can collaborate on future events.

COLLOQUIA SERIES AND SPECIAL LECTURES

In its seventh year, the STS Colloquia Series, headed this year by Professor Fischer, continued to be a core activity of the HSSST Doctoral Program. The series comprised of 21 speakers from such institutions as the Max Planck Institute for Wissenschaftsgeschichte, the California Institute of Technology, the Harvard School of Public Health, Stanford University, and the University of Manchester Institute of Science and Technology, and covered a wide range of topics from "Image and Logic: The Material Culture of Physics," to "Performing 'TAXOL': Facts, Actors and Imbrolios in the Biography of an Anti-Cancer Drug," to "The Sounds of Plasma Physics," to "Racial Discrimination and Health: An Epidemiologic Perspective." Professor Fischer organized five brown bag lunch discussions for HSSST doctoral students and STS faculty to have the opportunity to meet with directors of parallel interdisciplinary programs at the Royal Swedish Institute of Technology and at Rice University (Professors Svante Lindqvist and George Marcus), to have informal discussions of a student video-ethnographic exploration (Mr. Christopher Kelty's video done at the Whitehead Institute) and processes of doing ethnographic work in high tech but third world settings (Dr. Peter Redfield, Ph.D., University of California, Berkeley, on the French space station in French Guiana); or with visiting faculty on the background behind getting innovative work accepted (Professor James Livingston, Rutgers University).

OTHER ACTIVITIES

The *STS Newsletter's* fall issue focused on the transitions in the Program; the spring issue provided interesting statements by graduate students of their projects. The *STS Working Papers*, under the editorship of Professor Keniston, provides a means of disseminating early versions of work in progress. Landecker and Keniston were the two new *STS Working Papers* put out this year: "Seeking Cellvation™: HeLa Cells and Immortality" and "Software Localization: Notes on Technology and Culture." In the early fall, the Program hosted a dinner to salute Professors Smith and Keniston for their decade of leadership of the Program, and Professor Charles Weiner upon his retirement.

KNIGHT SCIENCE JOURNALISM FELLOWSHIP PROGRAM

Now entering their fifteenth year, the Knight Fellowships continue to attract science journalists from around the world to MIT to learn more about the research and innovation they cover. The fifteenth class of Fellows includes six journalists from the United States and three from Australia, Switzerland, and Japan. During their nine months on campus, Fellows attend some 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. Senior Research Associate Victor McElheny, an experienced science journalist who has been Director of the Knight Science Journalism Program from its inception, finished writing a biography of Edwin Land, the inventor of instant photography (deceased 1991), who was nearly 40 years a Visiting Institute Professor at MIT. More information about the Knight Science Journalism Fellowships can be found at the following URL: <http://web.mit.edu/ksjf/www/>

FACULTY ACTIVITIES

Professor Jed Buchwald edited and wrote the introduction for the journal *Archimedes*, Vol. I; and became co-editor of a series, *Studies and Sources in the History of Mathematics and Physical Sciences*. He wrote an article on "Mathematics in 19th Century Physics" (*Journal of the Center for Applied Computing*), and two obituaries for Thomas Kuhn. He received a \$300,000 grant from the Sloan Foundation's "Limits to Knowledge" program, and under it co-organized a workshop on "The Spectrum." He organized a Dibner Institute workshop on "The Electron." He joined the advisory boards of the American Institute of Physics and the 7 Pines Symposium (co-organizing a

meeting of the latter), and chaired the Nominating Committee of the International Union for History and Philosophy of Science. He gave talks at Tel Aviv, Notre Dame, Bologna, and Edinburgh.

Professor Fischer published three articles; five encyclopedia essays, two articles, and two reviews are in press. He gave papers at four conferences, and was the conference commentator at a fifth. He was an active editorial board member on four journals. He took a lead role in shaping and coordinating the new Core Course for the HSSST Doctoral Program, and co-taught a seminar at the Harvard Medical School in the Health Science Technology (HST) Program.

Professor Fitzgerald published two articles and lectured at the Virginia Foundation for the Humanities. She supervised two undergraduate theses, and served on five MIT committees. Outside MIT she served on the Society for the History of Technology's Dexter Prize Committee, was Advisory Editor for the journal *Technology and Culture*, served on the Nominating Committee of the History of Science Society, and served as co-editor of a monograph series at the Johns Hopkins University Press.

Professor Loren Graham, on leave during 1996-97, completed his book *What Have We Learned about Science and Technology from the Soviet Experience?* (Stanford University Press). He received the highest award of the History of Science Society, the George Sarton Medal, "for a lifetime of professional contributions to the history of science." His book, *The Ghost of the Executed Engineer*, was the subject of a panel discussion at the joint meeting of the AAAS and the Moscow Aviation Institute. He gave papers in Moscow on the development of philosophy of science in Russia, and in Norway on "The Abortive Effort to Reform Russian Science." He chaired the selection committee of the MacArthur Foundation for its fellowships in Russia, and serves on the selection committee for the McDonnell Foundation, which intends to give several large "Centennial Fellowships" to historians and philosophers of science. He also worked with Dr. Irina Dezhina, Visiting Scholar in STS, on an effort to engage American foundations in support for Russian science.

Associate Professor Hugh Gusterson's book, *Nuclear Rites: A Weapons Laboratory at the End of the Cold War*, was published by the University of California Press. Two articles were also published, "Nuclear Weapons Testing: Scientific Experiment as Political Ritual" and "Remembering Hiroshima at a Nuclear Weapons Laboratory." He attended six conferences, and presented seminars at MIT's Defense and Arms Control Studies and Center for International Studies. He served on the Institute's HASS-D Committee. He won a fellowship to be in residence at the Center for International Security and Arms Control at Stanford University in 1997-98.

Assistant Professor Evelyn Hammonds was promoted to Associate Professor effective July 1, 1997. She co-edited a volume, *Gender and Scientific Authority*; and published three articles in edited volumes on African-American feminism. She presented papers or keynote addresses at six conferences, served on the Program Committee for the Organization of American Historians, and on the Committee on Women for the History of Science Society. She co-taught a joint Harvard-MIT monthly workshop on race in medicine, anthropology, and biology. She led a faculty/graduate student workshop at the University of California at Berkeley's Department of African-American Studies on interdisciplinary studies. She supervised a UROP student project on "Black Male Physicians and Black Women Health Activists." At MIT she served on the Dean of Admissions' Search Committee, the Women's Studies Steering Committee, and the HSSST Doctoral Program Admissions Committee.

Professor Evelyn Fox Keller received an honorary doctorate from Lulea University in Sweden, gave six special lectures or keynote addresses, and nine conference or colloquia lectures around the world from Australia to Israel and Europe. In addition to five articles in press, she co-edited a volume on *Feminism and Science*, and was a member of the Gulbenkian Commission Report on the Restructuring of the Social Sciences.

Professor Keniston was on leave in the fall. He published two articles on software localization, and co-edited a volume on environmental issues for which he was the principle author of the introduction. He organized two workshops on software localization, one in Canada, and one in India; he gave talks in Italy and India.

Professor Mindell, the new Frances and David Dibner Assistant Professor of the History of Engineering and Manufacturing, designed a new course on the structure of engineering revolutions to be offered jointly with the School of Engineering in fall 1997. He served as the Undergraduate Academic Officer for the STS Program in the

fall. He gave an EECS colloquium on "The History of Control Systems," and presented a paper at the Dibner Institute Conference on the History of Atmospheric Flight.

Professor Theodore Postol attended conferences in Beijing, New York, and Washington on arms control, cooperation on nuclear challenges, and ballistic missile defense; he spoke at Carleton College, Stanford University, the Asia Society, and the Japan Institute of International Affairs. He published an article on "U.S. Missile Defense Activities Violate, Undermine ABM Treaty"; and has a second invited article in preparation. He received grants from the Carnegie Corporation of New York, W. Alton Jones Foundation, and the MacArthur Foundation. He served on the editorial boards of two journals, and as a consultant to the Office of Nonproliferation and National Security, Department of Energy Science and Technology Advisory Group. At MIT he serves as co-organizer of the Defense and Arms Control Studies (DACS) Technology, Defense and Arms Control Seminar series, and is a member of the Lincoln Laboratory Campus Interaction Committee.

Professor Smith received an honorary doctorate from the Rensselaer Polytechnic Institute in recognition of his "outstanding contributions to the history of technology." He was on leave during 1996-97 to work on the Sloan American History Textbook Project. He served as editor of the history of technology series at the Johns Hopkins University Press, as a senior advisor to WGBH's acclaimed television series, "The American Experience," on the Editorial Advisory Board of the Thomas A. Edison Papers, on the board of trustees of the Hagley Museum and Library, the Museum of American Textile History, and the Steamtown Institute.

Professor Sherry Turkle gave twenty-two lectures or conference papers (Simmons College Graduate School of Management, the Santa Fe Institute, the New School for Social Research, and the American Sociological Association, to name a few venues). A British edition of her book, *Life on the Screen*, was published, and translations were begun for editions in Chinese, German, Italian, Japanese, Korean, Portuguese, Spanish and Swedish. She published six chapters in books, and four articles in journals. She was a Fellow, World Economic Forum; Mentor, Ross School and Institute; Member, Massachusetts Women's Forum; Board of Directors and Board of Incorporators, *Harvard Magazine*; Editorial Advisory Board, *Science, Technology, and Human Values*; and Advisory Board, Computer Professionals for Social Responsibility. At MIT she served on the Committee on Privacy, the Communications Forum (her sixth year), and the Women's Studies Steering Committee (her 12th year). She served as an advisor to students from MIT (3), Harvard (1), and Brandeis (1).

FUTURE PLANS

STS hopes to fill three junior tenure-track lines. Searches will be run during 1997-98, with the hope of filling at least two positions for the academic 1998-99 year. The search process is designed to consciously and proactively pursue affirmative action to diversify our faculty. The task of reviewing the graduate program basic courses in the wake of the new Core Course will continue during 1998-99, as well as beginning a more serious review of the undergraduate offerings.

More information about the STS Program can be found on the World Wide Web at the following URL:
<http://web.mit.edu/sts/www/>

Michael M.J. Fischer

CENTER FOR INTERNATIONAL STUDIES

The Center for International Studies fosters faculty and student research on significant international issues. Beneath the surface of most current policy debates sit enduring empirical, theoretical, and historiographic conflicts. Center affiliates have addressed critical problems by conducting work on fundamental underlying issues and then linking that research to policy concerns. Initiatives in the areas of comprehensive security, technology policy, refugees and migration, democratization, ethnic conflict, political economy, and environment are discussed below. CIS research projects, seminars and workshops, fellowships, conferences and publications are part of an ongoing commitment to respond to the political and economic transformations of the 1990s.

SECURITY STUDIES PROGRAM

The MIT Security Studies Program, formerly the MIT Defense and Arms Control Studies Program, analyzes security alternatives available to the United States and other major and regional powers. Of great interest to the program is the role the United States will play in the world scene no longer dominated by the Cold War confrontation. The program also is examining the extent to which perceived economic and environmental problems are likely to affect international security arrangements, military options, and the resources made available for armed forces.

The Security Studies Program sponsors a number of working groups—research collaborations of faculty, staff and students—with each group adopting a distinctive format and topic. One, led by Professor Harvey Sapolsky, examines American defense policies and has been especially concerned with the effect casualties have on the conduct and political acceptability of war. A second, led by Professor Barry Posen, has concentrated on conventional warfare with special emphasis on nationalism-driven conflicts. A third, led by Professor Sapolsky, has been concerned with the impact the end of the Cold War will have on aerospace, shipbuilding, and research and development. A fourth, directed by Professor Theodore Postol, explores defense technology issues, most recently on the future of the ABM Treaty. A fifth, also led by Professor Sapolsky, has been examining the environmental legacies of the Cold War. A sixth, jointly directed by Professors George Rathjens, Carl Kaysen and Jack Ruina, has been exploring American national strategy and force requirements in a world filled with ethnic turmoil and failed states. A seventh, led by Professor Richard Samuels and offered in conjunction with the MIT Japan Program, looks at security issues in Asia. An eighth, led by Dr. Marvin Miller, studies proliferation problems. In addition, the program sponsors several seminar series including the SSP seminars, the Future of War seminars (joint with Harvard), the Star Series and the Weapon Seminars Series. Four major conferences were held: Chemical Weapons Treaty (our second annual defense environmental conference); Arms Trade (joint with Women in International Security); The First Admiral Levering Smith conference (a nuclear weapons series); the Fourth Annual James H. Doolittle conference (this year's topic was the Global Positioning System); and ASW After the Cold War, our invitational conference.

The director of the program is Professor Sapolsky, who has sought to encourage the initiatives mentioned above and to increase the program's research and public education activities. Among the Program publications are *Breakthroughs*, a research journal now in its seventh year; *DACS Facts*, the program's newsletter; *Security Studies Seminars*, reports on current topics; a working paper series; and the newly established *MIT Security Studies Conference* series. Major sponsors have been the Carnegie, Ford, and MacArthur Foundations. In addition to ten faculty members, thirty-five graduate students, eight post-doctoral visitors and scholars, four military fellows were affiliated with the program this year. MIT Japan Program Director Professor Richard Samuels is joining the Security Studies program, helping to integrate two major CIS programs.

PROGRAM IN DEVELOPMENT STUDIES

Research and training in development studies within the Center focused on questions of citizenship, ethnicity and nationalism, international migration and refugee movements, transnational linkages between developed and development countries, environmental policies, and governmental and trade reform.

The Inter-University Committee on International Migration, chaired by Professor Myron Weiner, continued its guest lecture seminar series on new approaches to the study of migration and refugee flows. The Committee received a grant from the Mellon Foundation to initiate a fellowship program on refugees and non-governmental organizations. The Committee organized a conference on "The Politics of Counting: Race, Ethnicity and Censuses in Modern

Politics,” funded by the Sloan Foundation, and directed by Assistant Professor Melissa Nobles (Political Science). The Committee also co-sponsored a workshop with the Institute for Economic Development of Boston University on the migration of scientists and engineers to the United States, directed by Professor Robert Lucas (Boston University). The studies prepared for the Committee’s workshops comparing Japanese and U.S. migration, refugee and citizenship, funded by the Japan Foundation Center for Global Partnership, will be published under the title *Temporary Workers or Future Citizens? Japanese and U.S. Migration Policies*, edited by Professor Weiner and Professor Tadashi Hanami (Sophia University). Several members of the Committee also participated in the project of the American Academy of Arts and Sciences on German-American Migration and Refugee Policies, chaired by Professor Weiner. Under an arrangement with the Office of the United Nations High Commissioner for Refugees (UNHCR) each year one of their staff members participates in the work of the Inter-University Committee on International Migration. The theme of citizenship, identity and migration was the topic of the MIT-Harvard Joint Seminar on Political Development (JOSPOD), co-organized by Professor Weiner (Political Science) and Jorge Dominguez (Harvard University), now in its 33rd year. The Program in Transnational Security, run jointly with the Center for International Affairs (CFIA) at Harvard and supported by the John D. and Catherine T. MacArthur Foundation, sponsored a workshop focusing on civil wars and the international response. The workshop was co-chaired by Associate Professor Stephen Van Evera (MIT) and Professor Bryan Hehir (Harvard).

The Ford Methodology seminar, a workshop funded by the Ford Foundation, focused on methodological issues in field research with presentations by faculty, guest lecturers and dissertation candidates. The workshop was organized by Dr. Elizabeth Leeds (CIS). The Seminar on Peoples and States: Ethnic Identity and Conflict, chaired by Professor Jean Jackson (Anthropology), continued its examination of issues of ethnic and nationalist identities in relation to the state. The Emile Bustani Middle East Seminar, organized by Dean Philip Khoury (History Faculty), continued its exploration of the issues of peace, conflict and democratization in the Middle East.

ACTIVITIES IN POLITICAL ECONOMY

Research and training activities in political economy continued to expand dramatically, with work clustering in two overlapping areas. One set of projects centers on national adaptations to an increasingly global economy. Projects in that area examine the economic and political consequences of increasing integration of markets for goods, technology, and capital. A second set of projects centers on how economic, security and environmental externalities might be addressed efficiently and effectively. Projects in that area have included a full range of conceptual and empirical studies.

- Joint Working Group on Transnational Economic Security: This MIT CIS and Harvard CFIA working group examined the effects of globalization on (1) the demand for private and public adjustment initiatives and on the financial capacity of firms and governments to facilitate adjustment; and (2) firm and governmental incentives to alter taxation, environmental regulations, and labor standards. This working group was co-chaired by Professors Kenneth Oye (MIT) and Raymond Vernon (Harvard) and was supported by the John D. and Catherine T. MacArthur Foundation.
- Professor Suzanne Berger and Ronald Dore published their symposium on *Convergence or Diversity*. The contributors to this book examine national political economies in the context of a global economy, examining the prospects for persistence of diverse national models of production and distribution and for convergence toward a common best practice.
- Several empirical projects focus on issues of comparative regulatory policy. Professor Meyer continued his study of the economic costs of heterogeneous environmental regulations in the 50 American states and on local environmental issues within the Boston metropolitan area. Professor Oye, Visiting Fellow James Maxwell, and graduate students Inger Weibust and Sandra Rothenberg expanded their studies on firm and governmental responses to differences in regulations between the US and Japan, within Canada, within North America and within the European Union. Finally, Professors Sapolsky, Oye, and Eugene Skolnikoff, Dr. Joanne Kauffman, Dr. James Foster, and Research Associate Sandy Weiner are launching a new program on regulation and risk with an initial emphasis on how scientific and technical information is incorporated into decisionmaking on environmental and health issues.
- Asia Energy, Security and Environment: This area is the focus of two major sets of activities. First, Japan Program Director Richard Samuels and Research Associate Michael Lynch have broadened their initiative on Asian energy security issues. Their working group on Asian Energy and Security is evaluating the relationship among conventional military, international economic, and energy security issues in East Asia. The 1996-97

working group meetings have provided a foundation for a major conference for fall of 1997. Second, two teams are examining local and international implications of coal combustion in China. Professor Karen Polenske is examining the human health effects of household coal combustion in China. This project is supported by NSF and by the Alliance for Global Sustainability and has been undertaken in conjunction with the Harvard School of Public Health. International aid and industrial coal combustion is the focus of a CIS joint project with Tsinghua University, Tokyo University and the Swiss Federal Institutes of Technology (ETH). The MIT team is lead by Professors Janos Beer and Adel Sarofim of Chemical Engineering and by Assistant Professor Zhiyuan Cui and Professor Oye of Political Science. The project is supported by diverse sources including the Japan Foundation, Asea Brown Boveri, the New Energy Development Organization, the Alliance for Global Sustainability and the MISTI program.

- Sustainable Development: Faculty Associate Professor Nazli Choucri organizes the Global Forum on Sustainable Development which focuses on technology, policy, and strategy dimensions of evolving global accords on environment and sustainable development. It is a collaborative initiative between international institutions, business and industry, and MIT as the lead institution of science and technology.

MIT JAPAN PROGRAM

In 1991, the MIT Japan Program was named by the Air Force Office of Scientific Research as one of the first four United States-Japan Industry and Technology Management Training (JITMT) Centers in the nation. This grant was renewed two years later and again in 1995, reflecting the high level of the Program's accomplishments. With funding from this award as well as from MIT's Ayukawa Fund, the Starr Foundation, and its Corporate Consortium, the Program continues to be the largest, most comprehensive, and most widely copied center of applied Japanese studies in the world. Dissemination of the Program's accumulated knowledge and experience is pursued through three sets of coordinated activities: education, research, and outreach.

Education is central, with placement of MIT science, engineering, and management students as interns in Japan at the core. Educational activities during the period under review were as follows:

- The Program placed 44 interns.
- The Program is also active in curriculum development and training. The Executive Seminar course on Japan and East Asia was offered for the sixth consecutive summer this year; the Program's sponsor retreat last October was attended by 30 individuals from industry and government; 32 Target Seminars were given during the period under review; and the Program's Video Series currently contains 50 titles and are an important tool for dissemination of information to individuals with time and/or budget constraints.
- The Program has been active in developing training materials on Japan including two CD ROMs, a workbook, and a case study book on building trust and negotiating with the Japanese.

In research, the Program undertook the following projects during this period:

- "The Re-emergence of Great Power Politics in East Asia: Is Japan Balancing China?," under the supervision of Program Director Professor Samuels.
- "Maximizing U.S. Interests With Japan in Science and Technology," also under the direction of Professor Samuels. "Manufacturing Competitiveness, Worker Skills, and Learning Strategies in the U.S. and Japan," undertaken by Dori Digenti, the Program's Director of Training.
- "The Changing Role of the Japan Technology Operations: Restructuring at Home and Expanding Abroad," a study headed by Professor Eleanor Westney of the MIT Sloan School of Management and E. Keith Henry, the Program's Tokyo Officer.
- "The Working Group on Asian Energy and Security," under the direction of Michael C. Lynch, Visiting Scholar at the Center for International Studies.

Japan-related research findings are also disseminated through the Program's Working Paper Series. During the period under review, 20 working papers were published.

Significant outreach activities this year have included:

- MIT Japan Program Distance Education Series, including seminars on Japan/China issues; on *Understanding Business Infrastructure in Japan and the Pacific Rim*; and on *Creating Effective Regional Strategies*
- "Japan in Transition: A New Competitive Environment" (workshop held in Tokyo)
- Continued publication of the MIT Japan Program Science, Technology & Management Report.

-
- Japan Science and Technology Databases.
 - Continued cooperation with the Institute's Department of Foreign Languages and Literatures on the JPNET (Japanese Network) Project to build a virtual community for Japanese specialists.
 - Continued cooperation with the MIT Libraries on the Japanese Scientific and Technical Information Project to create a national resource for Japanese scientific and technical information.
 - Continuation of the Program's dinner series, technology forum lectures, informal talks, IAP events, weekly Japanese lunch table with Japanese cultural activities, and Japanese film showings.
 - Development of web-based course on Japan and Japanese negotiation practices.

The Program's Corporate Consortium has 17 members, all of them large American multinationals—and the list of Japanese host organizations continues to grow.

MIT INTERNATIONAL SCIENCE AND TECHNOLOGY INITIATIVE

The MIT International Science and Technology Initiative (MISTI) creates and supports programs for the internationalization of education and research at the Institute. MISTI's objectives are to expand core resources for studying foreign societies on campus and to share a growing MIT base of knowledge about foreign science, technology, and industry through outreach programs in the US. MISTI/China has been the first focus of the project offering internships in mainland China, Taiwan and Hong Kong to students who wish to have the experience of working in a multinational company, laboratory or public service organization. MISTI/China also facilitates collaborations between MIT faculty and researchers in outstanding universities and laboratories in China.

- This year MISTI funded 12 faculty members to go to China to conduct collaborative research in a variety of disciplines. The researchers included Dr. Myron Spector, who went to China to set up a project with Tsinghua University to develop biomaterials which would be used in the fabrication of implantable medical devices.
- MISTI co-sponsored along with the MIT Japan Program several workshops including "The Regional Operations of Multinationals in East Asia" conference (1996), the Distance Education Series (1996-97), and the Executive Seminar on Japan and East Asia (1996 and 1997).
- *Made by Hong Kong* was a research project organized at MIT by the Industrial Performance Center and MISTI. The specific objectives of the study were to analyze the role of industry in the future development of the Hong Kong economy and to formulate recommendations for government, industry, and academia. The findings of the study were published this past spring in a book by Oxford University Press.
- MISTI sent 25 student interns to China in 1996 and sent 30 students in 1997. Last fall, MISTI became the sponsor of a new student internship program: the MIT Computer Education Technology Initiative (MIT-CETI). MIT-CETI was created by two MIT graduate students in electrical engineering: Ronald Cao and Jacob Seid. MIT-CETI provides opportunities for MIT students to go to China to help high schools to set up and maintain a Web server, and create home pages using HTML. This year MISTI funded internships in China for 13 MIT-CETI students. Ron Cao and Jake Seid were also recipients of the William L. Stewart, Jr. Award this year for their efforts in establishing MIT-CETI.
- MISTI hosted 5 visiting scholars this year including Prof. Jinglian Wu, one of China's most senior and respected economists. Professor Wu has been a leading thinker behind the "Socialist Market Economy" and the current economic reforms in China.
- This year MISTI sponsored 18 China Forum lectures and 15 films. A wide range of topics were covered including the reform of the Chinese legal system and the return of Hong Kong to China. In the fall of 1997, MISTI will launch a new lecture series entitled the *China Sustainable Development Forum*, managed by Dr. Joanne Kauffman.

MIT GERMANY PROGRAM

A new MISTI Program, the MIT Germany Program was launched in 1996 to provide 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 by working in German companies or research institutions.

- Through the MIT Germany Forum, the program ran a year-long movie series on pre- and post-unification problems, and on multicultural issues. It also sponsored lectures by renowned author and journalist Inge Deutschkron, and by the Distinguished Max Kade Visitor in the German section of the Department of Foreign

Languages, Turkish-German poet and essayist, Zafer Senocak. It co-sponsored the Lufthansa-Award for Excellence in the German Language.

- The program is funded by a start-up fund from the German Federal Ministry of Research, Education, and Technology. In the next two years, it plans to further its cultural outreach efforts, expand research projects with Germany, and serve as a clearinghouse for German students who would like to work in American companies.
- From 1998 on, Lufthansa will be sponsoring the interns' flights by becoming the program's "exclusive carrier."

SEMINAR XXI: FOREIGN POLITICS, INTERNATIONAL RELATIONS AND THE NATIONAL INTEREST

Seminar XXI is an educational program held, in Washington DC, for senior military officers, government officials and industry executives in the national security and economic policy communities. Conducted under the auspices of CIS, Seminar XXI recently completed its eleventh year and continues to enjoy great success. Professors Oye, Posen, and Weiner (Political Science) serve as Co-Directors, while founder Professor Berger remains active as a member of the Executive Committee.

The main objective of Seminar XXI is to develop among the program Fellows new analytic skills for understanding foreign societies, including the instincts to ask different questions about the facts they receive on the job, and in turn, to search out alternative interpretations of that data. Seminar XXI meets nine times over the course of the year, with each session focusing on a different foreign country or policy issue. The approach is not meant to cultivate country or functional expertise, but rather to provide concrete examples of the program's essential point: different frames of interpretation through which societies are understood yield fundamentally different answers to the questions policy makers must ask and resolve. By considering the politics of each country through different frameworks of analysis, the range of possible explanations for these countries' behaviors is widened, as is the range of US policy options that can be considered systematically. Each of the nine sessions brings together distinguished faculty from US and foreign institutions.

KALKER WORKSHOPS ON AMERICAN DIPLOMACY AND WORLD POLITICS

As an off-shoot of the Seminar XXI Program, the Center runs a parallel program at the State Department's Foreign Service Institute in Washington in which American diplomatic trainees of varying rank participate in a series of workshops dealing with salient issues in global affairs. This series, also bringing together government officials and distinguished faculty and other experts from American and foreign institutions explores American strategies appropriate to a contemporary global environment. Workshops are led by Professor Emeritus Lincoln P. Bloomfield (Political Science). They are funded by a generous contribution of alumnus Harry Kalker.

FELLOWSHIPS

Three fellowship programs provide funding for doctoral students and faculty seed research. The Program in Transnational Security, supported by the MacArthur Foundation is operated collaboratively with the Center for International Affairs at Harvard. Support is provided for research on (a) transnational economic security and (b) intergroup conflicts, human rights and refugees. Funding is available to doctoral students for academic year and summer support and to faculty for seed research support.

The National Science Foundation Traineeship in Democratization provides five fellowships annually for five years to support doctoral student training. Doctoral students from all social science departments at MIT are eligible to apply.

The International Energy Policy Research Grant competition continues to provide funding to faculty, researchers, and advanced doctoral students working on any aspect of international energy, environment and related technology policy. In 1996-97 five awards were given to students from the Departments of Political Science and Urban Studies and Planning.

In addition to these three fellowship programs, CIS research and outreach activities provide substantial support for graduate education. For example, the China Coal project supports three graduate students and the Seminar XXI Program supports two graduate students. In 1996-97, CIS programs provided support for approximately 30 graduate student FTEs plus approximately 50 MISTI and Japan Program interns.

OTHER ACTIVITIES

During 1996-97 CIS was host to visiting scholars from China, Russia, Israel, Turkey, Austria and Japan. In addition to the publications of the DACS (Security Studies) and Japan Programs, the Center publishes a bi-annual newsletter, *PréCIS*, and four working paper series. They are CIS Working Papers and *Findings*, a series of article-length summaries of recently completed social science dissertations in comparative and international studies. The latter is funded by a grant from an MIT alumnus. In addition the Center publishes the Migration Working Paper Series and the MacArthur Transnational Security Working Papers.

The Center draws its members from the MIT faculty and student body and its support staff through the MIT Personnel Department and our pool reflects the general commitment of MIT to affirmative action goals. General funds presently support part of the salaries of four people, one of whom is a woman. The Director of the Center is an Asian American and the Managing Director of the MIT Japan Program is a woman.

More information about this center can be found on the World Wide Web at the following URL:
<http://cis-server.mit.edu/cis/index.htm>

Kenneth Oye

WOMEN'S STUDIES PROGRAM

Women's Studies redresses the invisibility of women and gender in the construction of knowledge and reminds us to include women's as well as men's contributions, experiences and perceptions in understanding the world. The inclusion of Women's Studies subjects in the curriculum of an MIT student helps to produce an engineer, scientist, or business executive who is better-equipped to contribute fully and participate effectively in teams made up of men and women.

PROGRAM ADMINISTRATION

The program is directed by Professor Ruth Perry, Professor of Literature, and Founder of MIT Program in Women's Studies. During academic year 1996-97, the Women's Studies Steering Committee consists of Assistant Professor Evelyn Hammonds (STS), Associate Professor Diana Henderson (Literature), Professor Jean Jackson (Anthropology), Associate Professor Henry Jenkins (Literature and Film & Media Studies), Professor Evelyn Fox Keller (STS), Women's Studies Research Librarian Marlene Manoff (Humanities Library), Professor Perry (Literature), and Associate Professor Margery Resnick (FL&L).

CURRICULUM

The Program in Women's Studies offers an undergraduate curriculum consisting of core classes and crosslisted subjects from cooperative departments. Students may concentrate, minor and petition for a major departure in Women's Studies. The Program in Women's Studies offered eighteen subjects during the academic year 1995-96, with approximately 300 students enrolled. The program continues to be an active contributing member of the Graduate Consortium in Women's Studies (GCWS), a pioneering effort by faculty at six degree-granting institutions in the Boston area and Radcliffe College to advance women's studies scholarship in a series of team-taught interdisciplinary graduate seminars. This year, the GCWS co-sponsored three graduate level courses, in which one MIT graduate student enrolled.

HONORS AND AWARDS

Lily Koo '97 was the second recipient of the joint writing prize offered jointly by The Program in Writing and Humanistic Studies and the Program in Women's Studies. The Louis Kampf Writing Prize in Women's and Gender Studies honors both Professor Emeritus Louis Kampf's contributions to Women's Studies at MIT and rewards high quality undergraduate writing in women's and gender studies. The Prize is sponsored by Women's Studies and included among the annual writing prizes given by the Program in Writing and Humanistic Studies. The Prize is judged by faculty from Writing and Humanistic Studies and Women's Studies.

Professor Cynthia Wolff (Writing & Humanistic Studies) won both a Guggenheim and a National Endowment for the Humanities grant to continue her primary research on Willa Cather. Professor Henderson (Literature) won the Jephtha H. and Emily V. Wade Award and the Old Dominion Fellowship. Professor Fox Keller (STS) received an honorary doctorate from Luleå University in Sweden.

PROGRAM HIGHLIGHTS

- Maxine Hong Kingston read from her work-in-progress in an event that filled 10-250. It was co-sponsored by Women's Studies, Office of the Arts, the Dean of Humanities and Social Science, Literature Section, Foreign Languages & Literatures, and the Program in Writing and Humanistic Studies.
- Also well-attended was a panel discussion on "Generations of Feminism," featuring *Nation* columnist Katha Pollitt, Harvard School of Education Visiting Professor Linda C. Powell, Pam Prasarttongosoth '97, Alan Shihadeh 'G, Lamelle Rawlins--Harvard '99, and moderated by Professor Hammonds (STS).
- A series of events and films offered in connection to Women's Studies subject SP406 "Violence Against Women" was co-sponsored by Women's Studies and Amnesty International. In the fall, Wellesley Assistant Professor Kathy Moon (Political Science) presented on US Militarized Prostitution in Korea, Cambodian American Loung Un presented "Survivors of War, and Survivors of Domestic Violence: Both Were Prisoners, but Only One Is Blamed for their Imprisonment," and a screening of documentary, *When Women Unite: The Story of an Uprising*, which narrates the struggle of a group of women in the Indian village of Andhra Pradesh to ban the sale of arrack, a state-supplied distilled liquor. In the spring, *Calling the Ghosts: A Story about Rape*,

War and Women, a film examining the Balkan tragedy was screened and introduced by Lecturer Kim Mancuso (Theater Arts).

- “Noble Science and Nobel Lust: Disclosing Tribal Secrets” presentation by author and Stanford Professor Carl Djerassi on research ethics was co-sponsored by Women’s Studies, The WWW Ethics Center for Engineering and Science, and the Dean for Graduate Education.
- “The Changing Role of Women in Japan” film series was presented in connection with the freshman seminar on the changing status of women in Japan led by Assistant Professor Takako Aikawa (FL&L) co-sponsored by Women’s Studies, FL&L, and Film & Media Studies.
- IAP reading from *Sarah’s Psalm* and celebration of the retiring Bunting Institute director Florence Ladd (former associate dean of the School of Architecture and Planning) co-sponsored by Women’s Studies, the Office of the Undergraduate Education and Student Affairs, the Humanities Library, and the Office of the Arts.
- IAP three-session discussion group on Women in the Bible led by Chaplain Constance Parvey and co-sponsored by Women’s Studies and the Lutheran Episcopal Ministry at MIT.
- A cutting-edge, one-day conference, “From Barbie to Mortal Kombat: A Conference on Gender and Computer Games,” was sponsored by Women’ Studies, the Film and Media Studies Program, the Program in Science, Technology & Society, Media Lab, and the Deans of Engineering and Humanities and Social Science, and content organized by Assistant Professor Justine Cassell (Media Lab) and Professor Jenkins (Literature, Film & Media Studies). The 200+ attendance came from the MIT community and outside, including attendees from New York, California, and Canada.
- 1997 series of readings, “Colored Girls with Pens: Writing by Women of Color,” designed to showcase women of color authors, and co-sponsored by the Office of the Arts, Humanities Library, Women’s Studies, Wellesley Women’s Studies Department and New Words bookstore was presented all spring. It included Thulani Davis, Patricia Powell, Holly Uyemoto, Carmen Abrego, Nuar Alsadir, Sharan Strange, and Shirley Geok-Lim Lin.
- The Second Annual Off-Line Poetry Slam, funded by Council for the Arts and the DeFlorez Fund for Humor, appealed to a whole new constituency of MIT. This event was begun at MIT because of the students in the Women’s Studies subject SP452 “History and Politics of US Feminist Movements” offered in the spring of 1996. (A poetry slam is a competitive performance poetry contest with judges chosen randomly from the audience.)
- A lecture series on “Gender, Welfare and Poverty” was co-sponsored by Women’s Studies, Department of Urban Studies and Planning, and the Department of Political Science. The series featured five speakers chosen and introduced by Assistant Professor Aixa Cintron (DUSP). This series enriched her class, Women’s Studies subject SP470 “Gender, Work and Public Policy.”
- The Women’s Studies Brown Bag Lunch Lecture Series featured 10 local scholars, including these from MIT: Assistant Professor Aixa Cintron (DUSP), Assistant Professor Brenda Cotto-Escalera (Theater Arts), Lecturer Manju Mehta (Anthropology), Assistant Professor Maureen Scully (Sloan), PhD candidate Amy Segal (Sloan), and Lecturer Emma Teng (History).

RESEARCH, PUBLICATIONS, AND SERVICE

The Women's Studies Faculty continued their active contributions to their individual fields. Most of these accomplishments are listed in the reports of their home departments, so special attention is given here to achievements relating to work on gender.

Associate Professor Elizabeth Wood published the essay “Class and Gender at Loggerheads in the Early Soviet State: Who Should Organize the Female Proletariat and How?” (Laura L. Frader and Sonya O. Rose, eds. *Gender and Class in Modern Europe*, Ithaca: Cornell University Press, 1996), and gave an invited lecture at Brandeis

University entitled "Syphilization or Civilization: The Trial of the Old Way of Life in Revolutionary Russia, 1917-1930."

Professor Resnick (FL&L) is a consultant to Partners Advisory Committee on Women which is conducting a system-wide study of barriers to women's success in academic medicine (MGH, B&W's, Dana Farber, Mass Eye & Ear, Spaulding, McLean's). She also taught a seminar on "Women and Work" for the European Community out of Barcelona. She has completed two more oral history interviews on MIT women graduates; several more are ongoing.

Professor Fox Keller co-edited *Feminism and Science* with Helen Longino (1996, Oxford University Press).

Professor Hammonds co-edited with B. Laslett, S.G. Kohlstedt, H. Longino, and E. Hammonds, *Gender and Scientific Authority* (1996, University of Chicago Press). She published the following articles in edited volumes: "Black (W)holes and the Geometry of Black Female Sexuality" in *Feminism Meets Queer Theory*, ed. Elizabeth Weed and Naomi Schor (1997, Brown University and Indiana University Press); "When the Margin is the Center: African-American Feminism(s) and 'Difference'" in *Transitions Environments Translations: Feminisms in International Politics*, ed. J. Scott, C. Kaplan, and D. Keates (1997, Routledge); and "Toward a Genealogy of Black Female Sexuality: The Problematic of Silence" in *Feminist Genealogies, Colonial Legacies, Democratic Futures*, ed. M. J. Alexander, Chandra T. Mohanty (1997, Routledge). She is serving a two-year term as consultant on Women and Scientific Literacy Project for the American Association of Colleges and Universities. She serves on the History of Science Society's Committee on Women. She presented the invited keynote at the Berkshire Conference of Women Historians, and papers at the Berkshire Women's History Conference, and the Women in Philosophy meeting at the University of Memphis. She served on the Visiting Committee of the Women's Studies Program at Bates College, She supervised a UROP on "Black Male Physicians and Black Women Health Activists: Two Approaches to Health Care in the African-American Community, 1900-1950."

Professor Sherry Turkle served on the Massachusetts Women's Forum and presented the following lectures: "Identity in Cyberspace" (Alumnae Conference: Women and Leadership: Pathways to Power, Simmons College, Graduate School of Management); "Women, Learning, and Computers" (Wellesley College Center for Learning and Teaching); Keynote Address "Gender Trouble on the Internet" (Conference: Women of Influence: Breaking Boundaries and Challenging Paradigms, Women's Global Business Alliance); "Life on the Screen: Identity in the Age of the Internet" (Association for Women in Computing); "Gender in the Virtual World" (Women's Forum, Massachusetts Institute of Technology); Panelist in session "Making History in Cyberspace: Content Control, Gender, and Social Gaps" (Conference: Women Making History, International Women's Forum).

Professor Perry presented the following lectures: "Am I My Sister's Keeper? Intellectual Siblings in Eighteenth-Century England," (Center for Literary and Cultural Studies, Harvard University); "Art, Interdisciplinarity, and the Graduate Consortium in Women's Studies" (Pennsylvania State University); "Feminism and the Enlightenment" (Royal Holloway College, University of London); "The Graduate Consortium in Women's Studies" (Arizona State University). She presented the following conference papers: "Good Girls and Fallen Women: Representations of Prostitutes in Eighteenth-Century English Fiction" (Group for Early Modern Cultural Studies; American Society for Eighteenth-Century Studies); "Graduate Education in Women's Studies" and "Generations of Feminism" (Conference: Twenty-Five Years of Women's Studies, Arizona State University). She published the following pieces: "Building a Feminist Institution: An Informal History of the Graduate Consortium in Women's Studies" (*NWSA Journal*, 8, 2 Summer 1996); "Inventing a Feminist Institution" (*Graduate Women's Studies: Visions and Realities*, ed. Ann B. Shteir, Toronto: University of Toronto Press, 1997); review of T.G.A. Nelson's *Children, Parents and the Rise of the Novel (Eighteenth-Century Fiction* 9,1 - October 1996); review essay "The Contribution of Gender to the Evolution of the Novel" (*Modern Language Quarterly* 57, 4 December 1996); "Reflections on the writing of women's history" review of Gerda Lerner's *Why History Matters (The Boston Globe*, April 6, 1997). The following article of Professor Perry has been reprinted: "Women and Computers: An Introduction" (*Gender and Scientific Authority* ed. Barbara Laslett et al. Chicago: University of Chicago Press, 1996).

Professor Henderson represented MIT on the Board of Directors of the Graduate Consortium in Women's Studies at Radcliffe College. She presented the following papers: "Re-viewing Queen Isabel in *Henry V*" Seminar on Writing about Performances. Shakespeare Association of America, Washington, D. C.; "The Disappearing Queen: Looking

for Isabel in *Henry V*,” (Rocky Mountain Medieval and Renaissance Association, Banff, Canada) and (Meeting of the Group for Early Modern Culture Studies, Pittsburgh, PA). She completed five articles on Women’s Studies subjects that are in press and published the following review: *The Tears of Narcissus: Melancholia and Masculinity in Early Modern Writing* by Lynn Enterline in *Shakespeare Bulletin* 14.4 (1996): 43.

Lecturer Helen Elaine Lee has been appointed to assistant professor of writing. She has completed her new novel, *Water Marked*.

Professor Perry will continue as director for one more year.

Ruth Perry

SLOAN SCHOOL OF MANAGEMENT

This year marks the completion of the fourth year of Sloan's five-year plan for preeminence. In 1994 we introduced a new Master's Program curriculum that has met with high acceptance from both students and faculty. The new curriculum, with its introduction of communication courses, team learning, and five specialized tracks, is at least partially responsible for improving satisfaction scores and raising the yield in student acceptances of our offers to a new record (83 percent of students admitted accepted our offer in 1996). We have boosted our student admissions to 350 MBA students (including 50 Leaders for Manufacturing candidates), but decreased the average class size in the core curriculum by increasing the number of sections. Applications have more than doubled since 1993, and selectivity increased to eight applications for each position in the class.

INITIATIVES

Our educational initiative in system design and management (SDM) in conjunction with the School of Engineering has progressed with the completion of test classes and an SDM launch in January 1997.

Sloan aims to be a leader in remote education. We currently have 10 videoconference-ready classrooms and common areas. Several videoconference classes were held this year in our executive education and international initiatives.

Sloan's international initiatives are providing new resources for both curriculum development and research. Our initiative in China is moving forward, and eight faculty from two of China's most prestigious universities, Tsinghua and Fudan, in residence at Sloan.

In executive education, we are responding to market shifts by designing an innovative program combining traditional classes, remote learning through two-way video, and Web-based tools and databases.

A new research initiative—Inventing the Organization of the 21st Century—is under way.

The Entrepreneurship Center has raised \$10 million to hire new faculty and establish new entrepreneurship courses and programs.

RESTRUCTURING

To generate the resources for these initiatives, we have restructured so we can provide additional services with little increase in head count. Our new matrix organization has enabled us to be more flexible in the face of changing demand and to improve efficiency through the sharing of resources across programs. Staff productivity has increased by more than 25 percent.

Major realignment in the Technology Services staff has significantly increased support for faculty research and for implementing the SAP accounting system. Another program improvement this year was student laptop/networking support, mainly in response to a move toward group work and a greater need for computers.

In addition, the faculty are utilizing a new point-based load measurement system. As a result, teaching productivity has risen by more than 25 percent.

We are taking steps to improve the efficiency of the Research Centers and to build research revenues.

BUDGET

Our budget outlook remains healthy. We have been able to contribute resources to the Institute substantially above the level of our original five-year plan: \$7.3 million in incremental funds over the FY94–FY97 period (through reduction in general funds, profit sharing, and new overhead taxes) versus \$5.0 million originally projected. We forecast that we will contribute another \$14.6 million between FY98 and FY2002. We expect to achieve these results even despite a new program to respond to the increasing competition among business schools and to meet the attack on our faculty from the Harvard Business School.

Major issues we are now addressing are faculty compensation, interdepartmental students, and diversity. In spite of tight budgets, Sloan hired 19 new faculty this year, expanding our outreach and strengthening our accounting, finance, and marketing departments. In the area of understanding and nurturing diversity, we staged a day-long program in April which was attended by 300 students, faculty and staff. A similar event is planned for the fall of 1997.

It has been a very productive year resulting in the implementation of many of the programs outlined in the 1994 five-year plan.

Glen L. Urban

EDUCATION

MBA PROGRAM

Our mission is to create and deliver a small MBA program based upon collegiality and teamwork, an international focus, and a diversity of cultures and interests. The innovative and integrative curriculum aims to provide a strong analytical foundation to management, encourages the interplay of ideas and their practical application, and allows students to design an individualized educational program exposing them to leading-edge research and practice.

In 1996–97, student enrollment, including Leaders for Manufacturing, was 719, the largest in Sloan School history. The first-year MBA class contained 315 students. It had the following profile: 28 percent female, 13 percent U.S. minority, and 38 percent international, with an average age of 27.5 years and average work experience of 4.3 years. Of the students' undergraduate degrees, 49 percent were in engineering, 25 percent in social sciences/humanities, 20 percent in business, and 6 percent in math/science.

The fall of 1996 was the fourth year of the revamped MBA curriculum, in which students complete a fall core of six subjects and then choose a specific Career Management track or Self-Managed Track in the spring term. A new track in Manufacturing and Operations Management (MO) was approved by the Master's Program Committee and implemented in the spring term. MO students will join the LFM proseminar and share some LFM electives. Nearly half the MBA students elected to join 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.

Overall student satisfaction with the MBA Program remained high in 1997: 91 percent of MBA students rated their Sloan experience 7 or higher on a 10-point scale.

Forty-six members, or 13 percent, of the first-year MBA class were from underrepresented minority groups—Sloan's largest minority representation ever. The Class of 1998 includes 27 African-Americans, 9 Mexican-Americans, 9 Puerto-Ricans, and 1 Native American. They joined 16 second-year minority students.

The Sloan School provided significant financial support for its minority MBAs. During the academic year, Sloan funded 39 first-year minority MBA scholarships at \$10,000 each, and 15 second-year scholarships at \$5,000 each. Funding for these scholarships came largely from private donations as well as from General Electric, United Technologies, CMP Media Corporation, the Toigo Foundation, and Citicorp.

The Minority Business Club and Minority Student Support Group met regularly during the academic year to discuss minority student issues. Representatives from the MBA Program and Master's Admissions Offices also attended school Diversity Committee meetings and participated in the first schoolwide diversity training day in the spring term.

The MBA Program subsidized the membership of minority students in the National Black MBA and National Hispanic MBA associations, allowing students to attend national conferences. Résumé books were developed for both groups and were used at career fairs for these events.

U.S. News and World Report ranked the Sloan MBA Program #4 in the nation in its 1997 annual survey of graduate business schools published in March. The program's continued high rankings (#2 in 1996, #1 in 1995, and #2 in

1994) are recognition of our student selectivity, high graduation rate, career placement success, and academic reputation.

The MBA Program Office expanded the number of student international trips to 7, up from 6 last year and 4 in 1995. The international trips have become an important part of the MBA Program student experience. The trips are initiated by students (itineraries, logistics, and fundraising) and are supported by the MBA Program Office and International Management faculty. Each trip is preceded by a regional academic seminar that examines the relevant management, social, and cultural issues of the countries visited. The trip destinations this year were China; Japan and Korea; Cuba and Mexico; Brazil and Argentina; India; Singapore, Malaysia, and Indonesia; and Eastern Europe. Some 250 MBA students participated.

Lawrence Abeln

LEADERS FOR MANUFACTURING FELLOWS PROGRAM

The Leaders for Manufacturing Program (LFM) is a partnership between MIT and 20 U.S. manufacturing firms to discover and translate into teaching and practice principles that produce world-class manufacturing and manufacturing leaders. LFM supports students both as Fellows in the program and as research assistants throughout the Institute. Both groups of students participate in a research program that is directed by a joint faculty-industry committee.

The largest component of the educational efforts is the Fellows Program, a 24-month dual-masters degree (engineering and management) program involving a single integrative research project carried out on site in partner firms. Of the 45 students graduated in 1997, over 90 percent have taken positions in manufacturing firms; 30 students have taken positions with LFM sponsors, notably Boeing, Ford, Intel, and GM. Industry continues to show strong support for hiring LFM graduates. The class of '98 comprises 48 students; the class of '99, 42.

Research has been conducted with seed funding from LFM in diverse areas. The Organizational Change group, for example, has focused on how LFM helps its sponsoring companies to change. This initiative has resulted in an assessment of the real value of LFM to companies and provided recommendations back to the program and partner companies on how to better utilize graduates of the program.

Another initiative, the Next Generation Manufacturing project, has sought to address LFM's mission of discovering the principles for world-class manufacturing in the future. Phase one of the project, completed in January 1997, was partly funded by NSF and was performed with Lehigh University's Agility Forum and the TEAM program. Through extensive discussions with manufacturing practitioners, a set of principles has been outlined.

LFM is collaborating with Stanford's SIMA program on a project on remote diagnostics. Partner companies have strongly supported such joint research.

LFM has added Genzyme Corp. and Qualcomm, Inc., as new small and medium-size enterprise partners. Bay Networks, Inc., has moved from involvement through internships to become an official limited partner. (Inland Steel Industries is no longer an active partner.) Membership fees have been restructured to allow companies more flexibility in how they participate in program governance, internships, and research.

The LFM operating committee has developed four standing committees to focus on areas of critical importance: Fellows, Internship, Research, and Knowledge Transfer. The latter committee's charter is to improve effective transfer of program knowledge between MIT and the companies. To date a set of 22 "learning tools" (including cases, simulations, and exercises) have been developed from internship experiences for company and classroom use.

The National Coalition for Manufacturing Leadership (NCML), founded by LFM, met twice this past year to share knowledge about industry needs and program curricula. Tuskegee University joined the coalition for help in starting an integrated manufacturing program. The coalition now includes 14 universities.

A memorandum of understanding with Beijing's Tsinghua University was made to assist partner companies with operations in China and to offer opportunities for student and teaching exchanges with China. Informal ties are developing with four other technical universities in Mexico and Europe.

LFM'S goals for the coming year include:

- Enhancing the educational experience by more closely involving member companies in determining topics for internship projects; by achieving better integration between the teaching of engineering and management topics; and by integrating the leadership portion of the curriculum into a more continuous, less isolated set of experiences.
- Improving the research program by better integrating the Next Generation Manufacturing project.
- Expanding outreach by involving at least one foreign company in the program to reflect the global nature of manufacturing; by seeking students from foreign joint ventures and foreign subsidiaries of our partner companies; by hosting the next meeting of the Coalition of Manufacturing Leadership schools; and by developing a product-development course for industry leaders to disseminate LFM knowledge to a wider audience in our companies.

More information about LFM can be found on the World Wide Web at the following URL:
<http://web.mit.edu/lfm/www/>

Stephen C. Graves, David E. Hardt, William C. Hanson

EXECUTIVE EDUCATION

The mission of Sloan's Office of Executive Education is to be the preeminent provider 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. Consistent with this mission, the office achieved the following results in 1996–97:

Both the Management of Technology and Sloan Fellows Programs—which fall under the purview of Executive Education—successfully recruited large classes for 1997–98, indicating continuing strong demand for these mid-career management degrees. (See the separate reports that follow.)

Six executive short courses were successfully presented in May and June— The Chief Network Officer: Managing the IT Infrastructure; Negotiation: Theory & Practice; Management of Change in Complex Organizations; Corporate Strategy; System Dynamics: Modeling for Organizational Learning; and Product Design, Development, and Management.

Responding to market demand for more customized programs, Sloan increased its offerings of executive education programs for individual companies. For the second time, the School offered an innovative “change agent” program to Siemens Nixdorf.

We launched a new series of regionally focused programs in collaboration with leading institutions in India and Latin America.

The strategy for fiscal year 1998 includes the following:

- **Short Courses:** We are creating a richer variety of short courses targeted to specific needs emerging in industry. This effort will complement existing longer-term programs, for which demand remains strong. In particular, we have developed a new series of short (two-day) programs that will be offered multiple times a year to better meet the needs of managers and executives for “just in time” training. The first program, *Managing Technical Professionals and Organizations*, will be offered in September.

-
- Distance Learning: The new technologies of distance learning hold the potential to revolutionize executive education. We are building on the unique technical capabilities of the MIT community to lead in the development of this field. Our goal is to use this interactive medium to leverage the worldwide impact of our faculty, and of our extensive contacts with industry, to enhance the quality of education both on and off campus.
 - Research: We have reaffirmed our commitment to maintaining and expanding our research base as a means of adding value to our educational programs.

More information about Sloan's Executive Education activities can be found on the World Wide Web at the following URL: <http://web.mit.edu/sloan/www/academics/>

Robert Russman Halperin

Management Of Technology Program

The MIT Management of Technology (MOT) Program, the first joint program between the Sloan School and the School of Engineering, was established in 1981 to develop leaders capable of bridging technology and strategy within an organization. The program grants the special degree SM in Management of Technology.

The MOT Class of 1997—with 51 members, including 8 women—was the largest to date. As in previous years, the average age was 35, and average post-university work experience was 10.5 years. Some 55 percent of the participants were international, representing 19 countries, and 85 percent were sponsored by their organizations. Before entering the MOT Program, 43 percent had earned master's degrees, 15 percent PhDs.

For the first time, MOT participants and Sloan Fellows jointly took two required classes during the summer term. Professor Gabriel Bitran taught a half-term subject each in managing manufacturing and services. The groups enjoyed the interactions, but agreed that 113 participants were too many for this type of class.

For the annual MOT international trip, the class of '97 visited the People's Republic of China, Hong Kong, and Taiwan. Highlights included a three-hour conversation with Stan Shih (CEO of Acer) and a dinner with many of the CEOs from the Epoch Foundation.

The 1997 end-of-year surveys indicated an exceptionally high level of satisfaction among participants. On a 10-point scale, 34 percent gave the program a 10, and 37 percent gave it a 9. Overall, 94 percent of the respondents rated their satisfaction 7 or higher.

The MOT Program has begun to attract greater attention in the outside world. It was featured in two magazines this year: *Electronic Engineering Times* (January 20, 1997) and *National Society of Black Engineers* (March 1997). In addition, our new Web page received 20,000 visits in its first five months.

Our goals for the coming year are to strengthen our relationships with U.S. sponsoring organizations, to maintain our strong applicant pool, and to manage our rapid growth (from 41 participants in the class of '96, to 51 in '97, to 56 in '98) while maintaining our present staff size and level of customer satisfaction.

More information about the MOT Program can be found on the World Wide Web at the following URL: <http://web.mit.edu/mot/>

Rochelle Weichman

Sloan Fellows

The MIT Sloan Fellows Program entered the 1996-97 academic year with one of the largest classes over the 66 year life of the program and ended it with great pride as one of its alumni, U.N. Secretary General Kofi Annan, SF72, delivered the MIT Commencement Address.

The program strives to provide a learning community that reflects the international character of organizations today and to select participants with the highest potential for leadership roles. The 1997 class comprised 56 participants, all sponsored by their employers, of which 50 percent were U.S.-based organizations and 50 percent were international. This balance was achieved in the face of increased demand for places by Latin American companies, continued demand by Asian companies, and strengthening demand by U.S. companies. Participation by women and U.S. minorities, however, remained low, at 15 percent.

The teaching quality, as ranked by the participants, received the highest praise, as did program administration—an indication that stability has occurred after the extensive reorganization of the Sloan School.

For the first time, graduates were offered the option of choosing between the degree designations MBA or MS in Management. The majority elected the MBA. The thesis remains a degree requirement for Sloan Fellows.

The program will continue to cultivate a dynamic and balanced U.S./international learning community that cultivates effective leadership to meet the fast-changing demands of today's economic environment. Efforts will continue to increase participation by women and minorities.

Susan C. Lowance

DOCTORAL PROGRAM

Sloan's Doctoral Program aims to provide institutions in the United States and abroad with outstanding management faculty and researchers.

On the input side, we broke records this year. We received 484 applications from 57 countries, fully a quarter of them from China. We made 31 offers and got 19 acceptances (a yield of 61 percent, better than in past years). Total enrollment now stands at 93. The number of women in the Doctoral Program remains at 24 percent

On the output side, our total number of graduates for the past academic year was 26. Job success and placement have been exceedingly high in all 10 of our management fields. Recent graduates have found positions at Wharton, Harvard, the University of Chicago, Cornell, New York University, the University of Michigan, the University of California at Berkeley, the University of Rochester, the National University of Singapore, the Stockholm Institute of Economics, and the University of Chile in Santiago. A few graduates have chosen industrial careers at companies such as Booz, Allen & Co. and Digital Equipment.

While the number of underrepresented minority students (and applicants) remains small—currently three active students—we have undertaken several initiatives to increase our diversity. For example, we participate in the KPMG Peat Marwick PhD Project (an annual recruitment event) and have applied for and won a General Electric "Faculty for the Future" grant.

More information about Sloan's Doctoral Program can be found on the World Wide Web at the following URL: <http://web.mit.edu/sloan/www/academics/phd/>

Birger Wernerfelt, Sharon Cayley

VISITING FELLOWS

The Sloan Visiting Fellows Program provides opportunities to pursue full-time, nondegree studies tailored to individual professional goals and interests. Each Visiting Fellow's program of study, usually for one or two semesters, is designed in consultation with a faculty adviser.

Originally a small program with four to six participants a semester, the program has seen demand more than double. Thirteen participants are enrolled for fall 1997. Regular sponsors include Schlumberger and The Bank of Tokyo-Mitsubishi, Ltd.

We plan to continue to maintain the program as a means for students from other universities, as well as organizationally sponsored individuals, to pursue a path of independent study at the Sloan School.

More information on the Sloan Visiting Fellows Program can be found on the World Wide Web:
<http://web.mit.edu/sloan/www/academics/vf/>

Jennifer Mapes

SYSTEM DESIGN AND MANAGEMENT PROGRAM

See the listing under School of Engineering, page 339.

UNDERGRADUATE PROGRAM

During the 1996–97 school year, 62 seniors majoring in Management Science were graduated. The Department recognized Christina Hsu and Michael Liu with the Sloan School of Management Senior Prize.

As of spring, 163 students were enrolled in the Management Science SB program, and another 49 had selected Management Science as their second SB degree program at MIT. The total undergraduate enrollment of 212 represented a 19 percent increase over spring 1996.

A large number of students from other MIT degree programs continue to enroll in our management subjects. In the 1996–97 academic year, 804 such students enrolled, up from 784 the year before.

For the first time, the Undergraduate Program administered a satisfaction survey similar to that used by other Sloan teaching programs. On a 10-point scale, the average reported satisfaction with the Sloan School was 7.1; teaching, 7.5; faculty expertise, 8.5; and Sloan facilities, 8.3. Women were significantly more satisfied (8.8) with Sloan facilities than were men (7.5). Lower satisfaction levels were reported for faculty advising (5.8), for the bidding system (6.1), for Educational Services (6.3), and for MIT's Career Services (6.3).

Jeff Meldman, Heather Madnick

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 can help people work together better. The center has two corporate sponsors—Fuji Xerox and Anderson Consulting. Its activities are also open to sponsors from the 21st Century Initiative listed below. Government funding comes from a variety of sources, including ARPA, NSF, and the Defense Logistics Agency.

The past year has brought significant progress on the center's main project, the Process Handbook, a set of tools for inventing organizations which brings together both coordination theory and coordination technology. The center began beta-testing the Process Handbook software.

Other activities included a groupware workshop (cosponsored with Sloan's Center for Information Systems Research) and the publication of several working papers on a range of topics, among them the self-governing Internet, measures of the value of information technology, and bundling information. We also hosted a visiting scientist from Fuji Xerox.

In the coming year, we plan to continue developing the Process Handbook project and to go "live" with a Web version of the software in the next few months. We also plan further research and activities in electronic commerce and virtual organizations, and are exploring the possibility of creating a Future Organizations Lab for conducting basic research in this area.

Thomas W. Malone

Sloan School of Management

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 environmental economics since the late 1980s. Jointly sponsored at MIT by the Sloan School, the Department of Economics, and the Energy Laboratory, CEEPR receives financial support from corporate sponsors and government agencies in the United States and Norway. In conjunction with MIT's Center for Global Change Science, CEEPR cosponsors the Joint Program on the Science and Policy of Global Change, which conducts serious interdisciplinary work to provide a basis for global climate policy.

The principal achievements of CEEPR and the Joint Program in the past year fall into three categories:

- Increasing and broadening the sponsorship base: During 1996–97, the Royal Norwegian Ministry of Petroleum and Energy, Cyprus Amax Coal Company and the American Automobile Manufacturers Association joined as new sponsors for both CEEPR and the Joint Program. The G. Unger Vetlesen Foundation also became a contributor to the Joint Program, and CEEPR gained sponsorship from Vatenfall (the Swedish electric utility) and Bewag (the Berlin electric utility).
- Establishing significant presence in global change policy: The Joint Program's distinctive feature is the integration of streamlined but comprehensive economic, climate, and ecological models in one Integrated Global Systems Model. This integration was completed in 1996–97 and provided the basis for an enhanced role for the Joint Program's research in the formulation of global warming policy.
- Developing preeminence in the analysis of emissions trading: CEEPR has become the foremost interpreter of the U.S. Acid Rain Program, a pioneering public policy experiment in the use of tradable emission permits to achieve an environmental goal. The results of this two-year research effort have been published in a series of working papers.

Goals for the coming year include: continuing to expand the sponsorship base for both CEEPR and the Joint Program; maintaining the position and reputation attained in global warming economics and emissions trading; developing similar stature for research on productivity improvement in the supply of energy; and initiating a new field of research in energy futures, forwards, and arbitrage.

A. Denny Ellerman

CENTER FOR INFORMATION SYSTEMS RESEARCH

Established in 1974, the Center for Information Systems Research (CISR) investigates critical issues concerning the management and use of information technology in complex and dynamic organizations. Faculty associated with the center have conducted pioneering research in such areas as decision support systems, critical success factors, database systems, strategic IS planning, end user computing, executive support systems, and coordination technology.

In 1996–97, CISR research at the center was summarized in four new working papers and a white paper by center staff, and two working papers by affiliated faculty. Four previous working papers were published in *Sloan Management Review*. Staff are focusing on two key issues in IT management: the governance of the IT unit and management of ubiquitous information.

In addition to teaching in several Sloan graduate and executive education programs, CISR staff conducted an executive education course, Managing the IT Infrastructure for Global Competitiveness, in May for 22 IT professionals. In June, CISR held its annual Summer Session for 130 information technology professionals from all over the world. During the year, CISR staff participated in management education programs for IT professionals at Johnson & Johnson, a sponsor company. CISR held three one-day workshops on IT management issues and cosponsored a workshop on groupware with Sloan's Center for Coordination Sciences in March.

CISR research staff visited sponsor companies to discuss current research and to learn about their IT management issues. CISR research staff completed two case studies at sponsor firms on IT management initiatives, and began collecting data at a third firm.

CISR research staff made presentations at the International Conference on Information Systems (ICIS) and at two chapter meetings of the Society for Information Management. They served as reviewers for *Sloan Management Review*, *MIS Quarterly*, Harvard Business Press, and ICIS.

INTERNATIONAL CENTER FOR RESEARCH ON THE MANAGEMENT OF TECHNOLOGY

ICRMOT organizes a program of research on technology management, marketing, and production, as well as the interactions among these functions and their relationship to the global business strategies of member companies. The work is supported mainly by large technology-based companies that are facing the demands of complex and dispersed technology management, often on a global scale.

Current research topics include: using technology alliances to establish leadership in emerging technologies; understanding effective integration tools for dispersed development teams; metrics for valuing R&D; understanding and managing the episodic nature of innovation; recognizing cycles in commodity markets; and managing large-scale software projects.

The center has begun several new initiatives to increase the flow of knowledge to member corporations. Among other measures, we have begun to encourage members to serve as sites for MIT research projects (to ensure that the research is directly applicable to their concerns); we have started inviting members to small, interactive workshops at MIT and elsewhere; and we have encouraged members to participate in identifying companies that are world leaders in various aspects of technology and in holding workshops with representatives from these organizations.

William A. Lucas

INVENTING THE ORGANIZATIONS OF THE 21ST CENTURY

Inventing the Organizations of the 21st Century is a three-year-old research and education initiative that works with innovative managers, leaders, and academicians to help them invent the organizations that will become common 10 to 20 years from now.

The initiative has nine sponsor companies: British Telecom, EDS/A.T. Kearney, Siemens Nixdorf, Siemens PN, Eli Lilly, LG Electronics, McKinsey & Co., and—starting in 1996–97—Union Bank of Switzerland (UBS) and the Norwegian Business Consortium (Norsk Hydro, Norwegian Confederation of Business and Industry, Telenor, Norwegian School of Management).

In 1996–97, the initiative held two major meetings with sponsors. An executive meeting in June brought sponsor executives and liaisons together for an in-depth working session on the theme of radically decentralized organizations. An October research review presented sponsors with a broad range of research results.

Other activities included the development of a faculty steering committee for the initiative and the funding of a 21C Core Faculty Working Group, a cadre of faculty that has begun meeting to more fully develop a research approach and agenda.

In the year ahead, we plan to continue developing sponsorship. We are also redesigning the package of benefits for sponsors and possibly the structure of the initiative to allow more flexibility in working with companies and to securing funding for a broader range of faculty activities. We also plan to refine the thinking and interests of the 21C Core Faculty Working Group to create the intellectual underpinnings of our future work.

Tom Malone

LABORATORY FOR FINANCIAL ENGINEERING

The focus of the Laboratory for Financial Engineering is the quantitative analysis of financial markets using mathematical, statistical, and computational models. LFE's goals are not only to spur advances in financial

engineering, but to develop better ways to teach students and executives how to apply financial technology in corporate settings.

In the past year, we launched several new research projects. The new Artificial Markets Project examines the rich dynamics arising from interactions between human and artificial agents in a stochastic market environment in which agents learn from their interactions. In another new undertaking, the Trading Volume Project, we hope to expand our understanding of trading volume by developing well-articulated economic models of asset prices and volume, and empirically estimating them using recently available daily volume data for individual securities from 1962 to 1996.

During 1997, the LFE has produced 14 working papers and journal articles, on topics such as optimal control of execution costs, portfolio theory, and the stability of stock returns.

LFE's activities are supported through industry grants and private donations. This past year we received \$200,000 from Merrill Lynch to establish two Merrill Lynch Fellowships through the Operations Research Center, a pledge of \$500,000 from Gifford Fong to support the Track in Financial Engineering, and a donation of computer equipment from Sun Microsystems.

The Track in Financial Engineering, a part of the Sloan MBA curriculum, has also been supported by the LFE and has undergone a thorough review this year by the Sloan Dean's Office. The Dean's Office has promised more resources to support the track, and it will continue in its current form for at least another year.

The LFE continues to struggle with course development for the Trading Lab because of limited resources to fund this activity. I have developed several trading simulations for my investments course (15.433) and am developing research projects related to the Trading Lab (such as the Artificial Markets Project described above). The Trading Lab has considerably more potential from both research and teaching perspectives if resources can be raised to support it to the same extent that other universities support similar activities.

Andrew Lo

MIT ENTREPRENEURSHIP CENTER

The MIT Entrepreneurship Center (E-Center) seeks to inspire, educate, and understand entrepreneurs and the process of venture creation via a wide variety of entrepreneurial efforts throughout MIT and beyond. The E-Center is for those who would like to understand, match, or exceed this historic record of achievement by members of the MIT family.

The year 1996-97 has been a time of rapid growth for the E-Center. Student enrollment in entrepreneurship courses shot up 300 percent, to 327. We enjoyed record participation from MIT Engineering and Science students, and Entrepreneurship Lab course enrollment grew to 40-plus internships each semester.

We recruited four new faculty and practitioners, established a new core curriculum, and set up a five-year faculty and staff hiring plan. At the same time, the Entrepreneurship Center Advisory Board helped set our intellectual agenda for next 5 years. A key component of this agenda is the MIT Global Benchmarking Project, which started this year in Metz (France) and Plzen (Czech Republic). The project will compare and contrast policies affecting the growth and levels of entrepreneurship in 10 regions of the world.

The year has been fruitful on the financial side as well. Pledges of support from successful entrepreneurial alumni exceed \$9 million.

In the coming year, we plan to hold a National Conference on Entrepreneurship (with support from the Lemelson Foundation), increase our support for student-led venture activities such as the \$50K Business Plan competition, and recruit additional Entrepreneurs in Residence and other practitioners.

Kenneth 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 the global pharmaceutical industry—the firms and their suppliers, customers, and regulators. POPI seeks to improve the industry’s performance and reduce the cost of health care by lowering product costs and decreasing the time required to bring new products to patients.

In 1996–97, faculty associated with POPI continued research on case histories of important drugs, the cost of new drug development, the use of combinatorial chemistry to systematize key aspects of drug discovery, and many other topics. A large conference held at MIT in November 1996 examined “The Competitive Advantage of a Healthy Workforce.” Jointly organized with Pfizer, the meeting used some of the latest POPI research to stimulate a dialogue among invited corporate and health-services leaders.

Among other new collaborations, the directors of POPI have entered into preliminary discussion with the University of Leuven, Belgium, which plans to launch a study of the European pharmaceutical industry. Possible joint projects include cross-national comparative studies of drug development, project management, and outcomes assessment.

Stan N. Finkelstein

OPERATIONS RESEARCH CENTER

See the listing under Vice President for Research and Dean for Graduate Education, page 167.

SYSTEM DYNAMICS GROUP

The System Dynamics Group, founded in the early 1960s by Professor Jay W. Forrester, studies complex systems—often with the aid of computer simulation models—to learn how their structure influences their behavior.

In 1996–97, our National Science Foundation grant was approved for a third year. The National Model Project continued research on how the U.S. economy works. Participants in the System Dynamics in Education Project continued writing *Road Maps*, a series of self-study guides that use modeling exercises and selected literature to teach the methods and principles of system dynamics. Eight chapters are now available on the World Wide Web at <http://sysdyn.mit.edu/road-maps/home.html>.

More information on the System Dynamics Group can be found on the World Wide Web: <http://sysdyn.mit.edu/sd-group/home.html> and <http://web.mit.edu/sdg/www/>

John Sterman, Nan S. Lux

ADMINISTRATION AND SERVICES

ADMISSIONS OFFICE

This has been another highly successful year for Sloan Admissions. The new class is made up of 350 students, including the Leaders for Manufacturing joint Sloan/Engineering candidates. Continuing the trend of the past several years, the class is an experienced one, having an average of 4.6 years of employment before matriculating. The average age was 27.4 years. Average GMAT score has risen to 674.

The number of applications to Sloan again rose, to 3,394, reflecting a continued strong interest in the MBA professional degree, bolstered by a strong economy and job market. As business becomes more complex and reaches into sectors that were previously less business-oriented—such as health care—we have seen a diversification of applicants to include doctors, lawyers, architects, and other professionals who find themselves in need of sophisticated management skills to complement their professional expertise.

Sloan continues to be a diverse population on all dimensions. The incoming class is 37 percent international, 28 percent women, and 12 percent underrepresented minority students. In addition, students have come from all over

the United States, from backgrounds in engineering, mathematics, and the sciences, as well as from history, journalism, social science, economics, and business.

Plans for the coming recruitment season include renewed recruiting efforts in Europe as well as a continuation of our presence in Asia, South America, and across the U.S. and Canada. The voluntary participation of current students and alumni/ae in these efforts gives evidence of the satisfaction with our program.

Meg Manderson

ALUMNI RELATIONS OFFICE

The Alumni Relations Office aims to keep Sloan's 16,000 alumni connected with each other and the School, and to foster goodwill toward Sloan. Specific challenges for FY97 were to expand visibility of the programs and services available; to deliver on-line continuing education to alums; and to implement a new on-line alumni directory with a staff of three people.

FY97 saw the Sloan Alumni Relations program recognized by *Business Week* as one of the top five business school alumni networks; expansion of alumni clubs to 22 worldwide (a 30 percent increase); the School's first Web-based alumni course (Negotiation), which drew more than 30 alumni from six countries; expanded Web-based career services (on-line jobs listings); a new services brochure and alumni membership card; and the launching of a new Sloan memorabilia program to help promote the school.

In FY97, overall alumni activity and involvement was high. More than 150 alumni club events were held around the world, involving 2,000-plus alumni. More than 2,000 alumni volunteered to assist Sloan in recruiting, student mentoring, and admissions. Some 1,300 alumni purchased the new 1996 Alumni Directory. And the Sloan Alumni Interactive received more than 11,000 visits. Nearly 200 alumni took advantage of the personalized career counseling service. Reunion '97 attracted nearly 200 participants, including 48 percent of the class of '92.

Collaboration with MIT's Alumni Network Services will continue to play a critical role for Sloan alumni. Nearly 1,000 Sloan alumni have registered for the on-line directory and other networking services offered through ANS. In addition, more than 50 percent of the 1997 graduating class registered for the ANS services before they graduated.

Key challenges for FY98 will be to increase the visibility of the many programs and services available to alumni, including expanded value-added services such as alumni continuing education and distance learning. FY98 will also see a comprehensive survey of alumni on the value of their Sloan education.

More information on the Alumni Relations Office can be found on the World Wide Web:
<http://web.mit.edu/sloanalum/>

Carmon Cunningham

CAREER DEVELOPMENT OFFICE

The demand for Sloan graduates remained strong this year, though the competition is intense among the top schools for positions with prestigious firms. The two major challenges the Career Development faced this year were to manage the new fall recruiting schedule with minimum disruption to the academic mission of the school, and to increase the number of on-campus recruiters to keep pace with the larger student body.

Preliminary placement figures indicate mixed results, though they are brought on more by changes in student preferences than changes in overall demand. The median base salary dropped slightly, from \$78,000 to \$75,000, caused by a 5 percent increase in the number of students choosing careers in finance, accompanied by a four-point drop in consulting. The average number of job offers remained surprisingly flat at 3.2 (vs. 3.4 last year), considering that the class size had increased by nearly 20 percent in the same period.

Though head count in the Career Development Office has remained essentially flat (6 full-time plus 1.2 full-time equivalents), there has been significant expansion in all three of our main areas of business:

The recruiting season extended from late November into March this year, with 214 companies participating in on-campus recruiting and two career fairs taking place during the spring semester. Our marketing activities over the previous summer yielded 62 new recruiting companies, with the majority in the manufacturing sector. The CDO significantly expanded the use of technology to streamline recruiting operations, moving interview bidding/sign-ups, salary data collection, and job postings to the Web.

The CDO outsourced some of the career counseling activities this year, enabling us to offer a greater number and wider variety of seminars and workshops. Highlights included several seminars co-led with faculty and increased training in the use of Web-based job search services.

The CDO hired a new full-time librarian in January to manage the Career Resource Center and focus on job postings and on-line services. Our Web site has been expanded, and several new Web-based commercial databases are now available to students. We continually expand our collection and provide students with regular on-site training in use of electronic and hardcopy resources.

Our goals for the coming year are closely aligned with this year's goals. We plan to continue to increase the number and variety of on-campus recruiting companies, with special emphasis on international firms. We will also expand our counseling services, drawing on talented independent career counselors in Boston and New York. Most important, we will partner more extensively with Sloan's management tracks and individual faculty to integrate career seminars and information resources with the academic curriculum.

More information on the CDO can be found on the World Wide Web: <http://web.mit.edu/cdo/www>

Ilse Evans

CLIENT PARTNERSHIP AND RESOURCE DEVELOPMENT

FY97 was one of the best fundraising years in the School's history. The FY97 total of \$18,500,000 in gifts and new pledges represents a 27 percent increase over FY96. The Sloan Development Team (SDT) helped generate about \$12,000,000 in cash and more than \$6,500,000 in new pledges to support the School during FY97. The Sloan Annual Fund raised almost \$1,000,000, a 41 percent increase over the previous year, while an additional \$275,000 was raised to support the School's new Minority Fellowships program.

The SDT made 34 percent more sales calls than last year (937 versus 700), despite receiving no significant increase in its budget. Sloan's per-capita fundraising productivity is among the highest of the top tier business schools.

For FY98, the SDT has established a \$25,000,000 overall fundraising goal, including a goal of \$1,200,000 for the Sloan Annual Fund. The team will also redouble its efforts to close a \$25,000,000 gift by working even more closely with President Vest and the MIT Resource Development Office.

Ronald Thomann

EDUCATIONAL SERVICES

Educational Services continued this year to broaden its services supporting students and faculty, an especially important role as the population soared to an all-time high of nearly 1,100 Sloan students, with another 1,000 MIT students enrolled in Course 15 subjects. More than 160 course sections are now offered each semester, a massive scheduling task for this unit.

Increased communication was key this year: "Work in Process," a column for keeping students abreast of major decision processes at Sloan, was added to the weekly internal newsletter (*News@Sloan*). Educational Services manages and continuously improves a password-protected student intranet, which concentrates in one location a vast

range of necessary information resources. An on-line schoolwide calendar is being created. Management of on-line course materials is one of the new initiatives planned for next year, as a service to both faculty and students. Students arriving in the fall will find individual home pages created for them, complete with their photo (this will also help faculty to identify students).

In the area of enrollment management, the on-line course prioritization system was enhanced to meet a number of student and program needs: variable unit caps by program (enabling each academic program to determine the maximum number of units its students may take), extended bidding schedules for executive education students entering in the summer, system-produced materials such as class e-mail lists to provide new information for faculty, and, as always, a focus on faster response and more reliable electronic systems.

The newly formed Educational Services Advisory Group, which draws members from across Sloan's academic programs, has provided valuable direction for such projects as the refurbishment of the Sloan Lobby and desired renovation of other spaces.

In the 1997-98 academic year, Educational Services will play a vital role in distance learning, and plans to offer enhanced services in enrollment management. A comprehensive information system encompassing all aspects of a student's engagement with Sloan—from potential interest through enrollment through life-long alumni connection—looms on the horizon.

More information about Educational Services can be found on the World Wide Web at the following URL:
<http://web.mit.edu/sloan/www/Services/Edservices/EDS.html>

Lucinda Hill

LEMELSON-MIT AWARDS PROGRAM

The Lemelson-MIT Awards Program is a major national educational initiative designed to promote invention and innovation through prizes, spokespeople, and ongoing public education activities. In 1997, the goal of the program was to raise visibility of the awards and public awareness of the contributions of innovators in science, engineering, medicine, technology, and entrepreneurship.

Following are highlights of the program's success in achieving this goal: ongoing citation of the program and its public education activities in a wide range of outlets, including *ABC World News Tonight*; CNN's *Newsday*, and CNN's *Money Matters*; the *Tonight Show*; *The Wall St. Journal*, *BusinessWeek*, *Time Digital*, *The Washington Post*, *The New York Times*, *Wired On-Line*, and *Yahoo! News*; public endorsement of the program from national leaders, including Scott McNealy, CEO of Sun Microsystems, and Joseph Bordogna, acting deputy director of the National Science Foundation; increased international recognition of the awards, including coverage in *Le Monde* (front page), the *International Herald Tribune*, the *London Daily Telegraph*, and Japan's Science and Technology Television Network; expanded reach to primary school audiences, including ongoing presentations by spokespeople at the Smithsonian Institution and selected schools nationwide; fulfillment of national and international requests to incorporate program resources, such as the weekly inventor profiles, into multimedia educational materials; indefinite extension of a program-sponsored interactive kiosk at Disney's Epcot Center; and citations by primary and middle school educational organizations such as *Discover Magazine's* School Science Program, The Exploratorium's Cool Sites for Kids, and several regional parent's publications.

Douglas Engelbart, inventor of collaborative computing, hypertext, and community network systems and the computer mouse, was awarded the half-million dollar Lemelson-MIT Prize. Gertrude Elion, creator of numerous lifesaving drugs, including two to combat acute leukemia and one to facilitate organ transplantation between nonrelated donors, was honored with the Lemelson-MIT Lifetime Achievement Award. Nathan Kane, an MIT Mechanical Engineering graduate student and inventor of several industrial design innovations, was awarded the \$30,000 Lemelson-MIT Student Prize.

The goal of the program this coming year is to strengthen existing relationships, such as with the Smithsonian Institution; to build alliances with relevant internal programs, such as the new Center for Innovation in Product

Development; and to cultivate external collaborations with nonprofit and corporate initiatives supporting science and engineering outreach programs. In addition, activities to increase visibility will be targeted to a more select group of publications and media outlets.

More information about the Lemelson-MIT Awards Program can be found on the World Wide Web at the following URL: <http://web.mit.edu/invent/>.

Annemarie Amparo

OFFICE OF COMMUNICATION

The Office of Communication aims to clarify, coordinate, and broadcast key messages that demonstrate the Sloan School's preeminence in management education and research.

In FY97 the office underwent considerable reengineering and reorganizing to make the most efficient use of resources while increasing the visibility of the School. We put in place a system for better managing relations with the news media, coaching faculty and administrators on how to enhance Sloan's image in their contacts with the press. We initiated an effort to improve coordination among Sloan's many program brochures. We conducted a major reevaluation of the School's news magazine, *MIT Sloan R.O.I.* And we began a much needed overhaul of the Sloan Web site.

Goals for FY98 include:

- Creating a consistent body of images, messages, and editorial and design resources upon which program administrators can draw to create or update printed materials.
- Developing an all-purpose Sloan brochure that can be used in conjunction with other materials.
- Repositioning *MIT Sloan R.O.I.* so that it better serves the needs of its diverse audiences.
- Establishing systems for promoting Sloan internationally.
- Devising a Web strategy that makes information on Sloan easier to access and that ensures consistent and orderly maintenance of the School's many Web pages.

More information about the Office of Communication can be found on the World Wide Web at the following URL: <http://web.mit.edu/sloan/resources/comm.html>

Mary Schaefer, David Brittan

SLOAN TECHNOLOGY SERVICES

Sloan Technology Services (STS) works to create partnerships among faculty, staff, students, and corporations dedicated to the support of teaching and the best uses of IT, innovation and implementation of new technologies, lifelong learning, and changing infrastructure within an electronic community.

STS undertook a number of new initiatives during FY97:

- Support for student laptop computers. Students can now use the machines throughout Sloan buildings without our having to manually assign/reassign IP addresses.
- Increased support for faculty research. One full-time STS staff member (with a PhD in Statistics) is now assigned to research support, and a new lab with Unix, Mac, and NT systems was opened for PhD students. The Trading Room was officially opened in spring 1996 and one or two half-time research assistants provide database and other research support to faculty and students. More efforts are needed in this area to provide faculty with the level of support of other major business schools.
- Development and incorporation of Web-based course management software. Work was started to incorporate the Web into on-campus and remote Sloan classes with the use of course management software to "standardize" Web pages for Sloan classes, facilitate group on-line discussions, support a schoolwide calendar, and encourage asynchronous dialogues.

-
- New distance learning and videoconferencing programs. Faculty have taught and co-taught, hosted office hours, spoken at conferences and consulted over video. The Sloan Live series offered lunchtime videoconferences to alums and allowed remote participants to ask questions after short faculty presentations. Professor Robert McKersie taught a Web-based class on negotiation to some 30 alums around the world. Sloan faculty, staff, and students have participated in more than 400 videoconferences since January 1996.

Plans for FY98 include: the building of an electronic learning community (and its related infrastructure) for prospective students, current students, faculty, staff, alums, and partner companies through the use of technologies such as videoconferencing, audioconferencing, and the Web; improved teaching and learning through the use of technology; more standardization of faculty, staff, and students' hardware and software (including a phase-out of support for Macs); increased faculty research support; and improved administrative systems.

SLOAN MANAGEMENT REVIEW

Sloan Management Review is a peer-reviewed management journal that disseminates research from the top business schools, with the dual purpose of affecting management practice and publicizing the Sloan School. *SMR* has had a good year. Revenues, profits, circulation size, and citation levels exceeded expectations and were at an all-time high.

- **Finances:** The journal is closing FY1997 with revenues of \$1.6 million and earned operating profits of over \$800,000. We were able to contribute over \$400,000 to the School's operating expenses.
- **Circulation:** *SMR*'s paid circulation is now over 21,000, up 4 percent from last year despite significant price increases. Renewal rates are holding steady at 54 percent.
- **Impact:** *SMR*'s citation and impact ratings, measured by the Social Science Citation Index, were higher than ever. It was ranked 7th in management journals. (Until last year, it had been ranked 13th or 14th.) Only one managerially directed journal has a higher ranking. In addition, permissions and reprints sales continue to grow.
- **Editorial:** Eighty-one percent of the academically generated articles came from top-20 business schools; of those, six were from MIT faculty. Well-known authors included Edgar Schein, Thomas Malone, Wanda Orlikowski, John Rockart, Erik Brynjolfsson, Lynne Markus, Henry Mintzberg, Leonard Berry, Hau Lee, D. Quinn Mills, Thomas Davenport, James Brian Quinn, and John Sviokla. This year we introduced a new department, Executive Briefings, which has been received enthusiastically by readers.

In the coming year, we plan to redesign the journal, add another new editorial department, update our electronic offerings, and continue to increase revenues from permissions, reprints, and advertising. Revenues, profits, and circulation numbers are projected to go up modestly.

Sarah Cliffe

SCHOOL OF SCIENCE

The School of Science at MIT continues to play a leadership role in science education and research both nationally and internationally. Our faculty received a broad array of honors and awards during the past year, internal and external, national and international. We note particularly the appointment of Professor Mario J. Molina of EAPS and Chemistry to the position of Institute Professor. Various studies including especially the NRC study of Research Doctorate Programs in the United States show that our graduate programs quite broadly are ranked among the top few in the Nation. The one exception is neuroscience where we are in a building phase. Of course, maintaining this high standard in the future will require continued dedication and diligence by all of the members of our community, especially in an era of diminishing resources.

Our education programs continue to evolve and improve in response to ever-changing conditions. Mathematics has extensively revised introductory calculus 18.01 and has introduced an "intermediate difficulty" freshman calculus sequence 18.01A and 18.02A; the latter has proven to be quite popular. Biology has been successfully introduced into the core curriculum and is continuing quite successfully. One result of adding Biology to the core is a dramatic increase in the number of Biology majors over the past several years. Physics introduced a major change in the structure of 8.01 with most of the teaching taking place in small sections of ~ 20 students; this approach is now being evaluated. EAPS has revamped its educational program, especially at the graduate level, with an emphasis on a systems approach and has introduced a professional masters degree in Geosystems. BCS has revamped its Cognitive Science major dividing it into four core areas and has introduced a neuroscience major. Overall, after EECS, the departments with the largest number of undergraduate student contact hours at MIT are, in order, Mathematics, Physics, Biology and Chemistry. Further, Biology is now the second most popular major after EECS. Thus, the School of Science continues to carry a major part of the undergraduate teaching responsibility at MIT.

In 1993 the School of Science established the "School of Science Teaching Prize for Graduate Education" to complement the prize for undergraduate education established by John Deutch in 1983. The 1997 winners of this award were Professors Mounji Bawendi of Chemistry and Edward Farhi of Physics. The School of Science Teaching Prize for Undergraduate Education was won by Tomas Arias of Physics. John Essigman of Chemistry and Toxicology was selected as a MacVicar Fellow in FY97.

The quality of an academic enterprise such as the School of Science is determined primarily by the caliber of the faculty who make it up. Thus, one of the highest priorities of the current administration in the School has been to support properly our existing outstanding faculty as well as recruiting to MIT exceptionally talented young educators and researchers including especially women and underrepresented minorities. In 1996-97 six new faculty joined the School as assistant professors and three additional faculty were appointed as full professors. We also have had to stave off an unprecedented number of outside offers to our most distinguished faculty. We were, unfortunately, not always successful in this endeavor. A large number of School of Science senior faculty took advantage of the early retirement program in FY97. This has provided most departments with significant opportunities for recruiting new faculty.

One of the most significant events of the recent past was the formation of the Committee on Women Faculty in the School of Science. This committee was created as the result of an initiative which involved all of the senior women in the School of Science. The committee has multiple purposes and responsibilities. First, the committee has collected data to be used in assessing the status and equitable treatment of women faculty in the School of Science. Second, the committee is facilitating communications between the women faculty and the dean and department heads. Third, the committee is acting as a resource for the Dean of Science and the department heads. Finally, the committee is also serving as a resource to the MIT community as a whole to provide advice about issues of concern to women faculty at MIT. The committee submitted its first official report in FY97.

There are many new research initiatives in the School of Science. One of the most significant is our newly established partnership with the Carnegie Institution, the Harvard Smithsonian, the University of Michigan and the University of Arizona in the Magellan Project; this involves the design and construction of twin 6.5m telescopes at Los Campanas in Chile. In addition, the Alpha Magnetic Spectrometer (AMS) is scheduled to be one of the premier scientific experiments on the International Space Station to be launched in 2001. The AMS project,

which involves an international consortium, will look for anti-matter and dark matter candidates above the Earth's atmosphere. MIT, in partnership with the Whitehead Institute, continues to play a leading role in genome research.

Fund raising in the School of Science reached all-time highs over the past two years with total cash received approaching \$40M. Of particular note is the "Chemistry Campaign 2000."

ACADEMIC PROGRAMS

There were 882 undergraduates in the School of Science during the past academic year, a 3.40% decrease from the previous year. The number of minority students at the undergraduate level changed as follows:

| | |
|------------------|--------------------------------------------|
| Blacks | Increased from 37 to 41 (10.81% increase) |
| Hispanics | Increased from 48 to 62 (29.17% increase) |
| Native Americans | Decreased from 8 to 2 (75% decrease) |
| Asian Americans | Decreased from 289 to 279 (3.46% decrease) |

The female undergraduate population increased from 418 to 434 (3.83%). Twenty-seven percent of the Institute's upperclass undergraduates were enrolled in the School of Science.

Graduate enrollments in science decreased from 1,059 to 1,001. The total enrollment represents 19 percent of the graduate population at MIT. The number of minority students at the graduate level changed as follows:

| | |
|------------------|-------------------------------------------|
| Blacks | 19 to 23 (21.05% increase) |
| Hispanics | Increased from 19 to 23 (21.05% increase) |
| Native Americans | No change (0) |
| Asian Americans | No change (51) |

The number of female graduate students decreased from 316 to 295 (-6.65%). However, the overall percentage of female graduate students stayed unchanged at 30%.

The 262 faculty members in the School this past year represents a 5% decrease from the previous year. The undergraduate student-to-faculty ratio was 3.3 to 1, and the graduate student-to-faculty ratio was 3.8 to 1.

RESEARCH VOLUME

The FY97 research volume was \$118 million, a 4% decline over the FY96 research volume.

Robert J. Birgeneau

DEPARTMENT OF BIOLOGY

The Biology Department currently has 59 active faculty members of whom 13 are located in the Whitehead Institute, 12 are located in the Center for Cancer Research, 4 are joint appointees with the Department of Brain and Cognitive Sciences, 1 is joint with Chemistry and 1 is joint with the Department of Civil and Environmental Engineering. Including active Emeriti faculty, 4 of the faculty are Nobel laureates, 25 are members of the National Academy of Sciences and 9 are investigators of the Howard Hughes Medical Institute. The department has a very strong international reputation in research and teaching and has been a leading contributor to the development and application of molecular biology.

EDUCATIONAL ACTIVITIES

In the past year, the number of undergraduates registered as Biology majors was 435. We now have the second largest number of majors following electrical engineering. The Bachelor of Sciences in Biology degree was awarded to 156 students this past year: 137 in the regular Course VII Program, 19 in the VII-A Program.

A number of Biology majors received awards in 1996-97. Pardis Sabeti was awarded a Rhodes Scholarship and Ramy Arnaout was named a Marshall Scholar. The Whitehead Undergraduate Prize, given to an undergraduate majoring in Biology, who shows outstanding promise for a career in biological research as demonstrated by academic scholarship and contributions to research and to the MIT community, was awarded to Avital Rodal. The recipients of the John L. Asinari Award were Rachel Fezzie and Mala Murthy in recognition of outstanding undergraduate research in the field of life sciences. Sophie Currier was the recipient of the Salvador E. Luria Prize honoring outstanding scholarship and research of publication quality. Sarah Tegen received the Ned Holt Prize for excellence in scholarship and service to the MIT community. The Laya W. Wiesner Award recognizing the undergraduate woman who has most enhanced community life went to Shonna Hsiang Yin. Yessica Cabrera received the Albert G. Hill Prize, awarded to minority juniors or seniors who have maintained high academic standards and have made continued contributions to improvement of the quality of life for minorities at MIT. Second place in the Boit Manuscript Prize for drama went to Dena E. Cohen and Karyn January Cheng took first place in the Robert A. Boit short-story category. Lily Koo received the Louis Kampf Prize in Women's and Gender Studies. Jenny Yung Liu received second place in the Writing and Humanistic Studies Prize for Scientific and Engineering Writing. The 1997 Randolph G. Wei UROP Award went to Avital Rodal for outstanding work at the interface of life sciences and engineering. The following biology majors were elected to Phi Beta Kappa: Joel Budman, Lina Chen, Karyn Cheng, Sophie Currier, Suma Dutta, Amit Etkin, Melina Fan, Yanwen Hu, Erin Janssen, Betty Nvien, Rebecca Perlow, Avital Rodal, Amy Schwartz, Leejee Suh, Mayukh Sukhatme, Daisuke Tsujimoto and Graham Warden.

A new advanced course for undergraduates was offered this past Spring: 7.27, Principles of Human Disease.

During the period from July 1, 1996 to June 30, 1997, 27 Ph.D. degrees were awarded in the Department; and 3 Ph.D. 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 Department in 1995-1996 was 196, with another 30 in the Joint Program. The entering class in 1996, including 1 in the Joint Program, was 24. The class arriving in September, 1997 will be 22 students, with an additional 8 students in the Joint Program.

RESEARCH

The research activities of the department are in the areas of biochemistry, genetics, microbiology, cell and developmental biology, immunology, neurobiology, and virology. The FY97 total direct cost of research in the department (including the Center for Cancer Research and the Whitehead Institute) was approximately \$59.2 million, \$29.5 million of which was at the Whitehead Institute. MIT overhead on the funding in the department and the Cancer Center was approximately \$8.5 million.

There were many research achievements over the last year, too numerous to all be mentioned here. There were, however, several significant advances in the areas of human health and disease. Professor David Page and collaborators uncovered a role in male fertility for the Y chromosome. These studies could increase our understanding of male fertility and could lead to new diagnostic techniques for infertile men. Professor Hermann Steller continues to explore cell suicide mystery. Using *Drosophila*, Professor Steller's laboratory has discovered a

gene called *Drosophila* caspase-1 which is critical to causing programmed cell death similar to that in mammals. The identification of this caspase is an important step in understanding the mechanisms of cell suicide. A nine-person scientific team at the Center for Learning and Memory, headed by Professors Susumu Tonegawa and Matthew Wilson, reported in the December 27th issue of *Cell* on how the mouse brain forms spatial memories. The study involved a molecular, behavioral and electrical study of how animals develop spatial memory of a new environment after just a few minutes of exposure. The researchers developed a method to create mice in which the deletion of any gene of interest is restricted to a sub region or a specific cell type in the brain. This new genetic technique is likely to revolutionize the field of brain research. An international team of genome laboratories reported in the October 25th issue of *Science* on the mapping of a fifth of the human genome. The gene map establishes the location of more than 16,000 human genes. Professor Eric Lander, Director of the Whitehead/MIT Center for Genome Research, and others at the Center were participants in this consortium. An MIT group, led by Professor Lander, and Scandinavian researchers located a gene that may underlie many cases of Type 2 diabetes and may open the way for new treatments. Professor Peter Kim and his laboratory discovered a vulnerable region in the HIV envelope. In the April 18th issue of *Cell*, they reported on the crystal structure of a key fragment of the HIV envelope protein. This work on the protein fragment that enables HIV (the AIDS virus) to invade human cells has implications for new drug design. Professor Leonard Guarente is broadening his studies on aging to research in mice and is working on developing a visual marker for aging in transgenic mice.

PERSONNEL

Professor David Page was promoted to full Professor, effective July 1, 1997. Professor Tyler Jacks was promoted to Associate Professor with tenure and Professor Tania Baker was promoted to Associate Professor (without tenure).

Four new faculty members, previously reported, assumed their positions this past year: Drs. David Bartel and Andrew Chess joined the Whitehead Institute and Department of Biology as Assistant Professors; Dr. Sylvia Sanders also joined the Department as an Assistant Professor, and Dr. Guosong Liu arrived to establish his laboratory.

We are pleased to report that Drs. Ilaria Rebay, Frank Gertler and Paul Garrity have accepted positions in the Department.

Dr. Rebay will join the Whitehead Institute and the Department as an Assistant Professor. She plans to continue her investigations of the role of cell-cell interactions in coordinating developmental decisions in multicellular organisms, using a multifaceted approach of molecular, cellular, biochemical and genetic techniques. Dr. Rebay received her Ph.D. from Yale University and is doing postdoctoral work at the University of California, Berkeley.

Dr. Frank Gertler will join the Department as an Assistant Professor during the next academic year. He received his Ph.D. from the University of Wisconsin-Madison and is doing postdoctoral studies at the Fred Hutchinson Center for Cancer Research. He plans to use genetic cell biological and biochemical approaches to investigate the role of the gene *Mena* (Mammalian Enabled) and related proteins in the control of cell morphology and motility.

Dr. Paul Garrity will also join the Department as an Assistant Professor during the next year. He received his Ph.D. from the California Institute of Technology and is currently doing postdoctoral work at UCLA. He is studying molecular signaling events involved in target selection, using *Drosophila* as a model system.

Five faculty took advantage of the special MIT retirement incentive plan: Professors Gene Brown, Arnold Demain, Maurice Fox, Sheldon Penman and Phillips Robbins retired during the past academic year. They continue in the Department with part-time appointments as Professor without tenure and are active in the Department's educational and research programs. In addition, Professors Malcolm Gefter and Ethan Signer will retire on June 30, 1997 and will become Professors Emeritus.

It is a pleasure to report the following honors and awards to Biology faculty during the past year:

Andrew Chess received a Rita Allen Foundation Scholar Award.
Sallie Chisholm received a Guggenheim Fellowship.

Arnold Demain was named a Corresponding Member of the Mexican Academy of Sciences; received an honorary doctorate from the University of Leon, Spain; and received the 1997 Marvin J. Johnson Award in Microbial and Biochemical Technology from the American Chemical Society.

Gerald Fink was elected to the Institute of Medicine of the National Academy of Sciences, and was elected to fellowship in the American Academy of Microbiology.

Alan Grossman received the 1997 Eli Lilly & Co. Research Award from the American Society of Microbiology.

H. Robert Horvitz received the Ciba-Drew Award for Biomedical Science.

Richard Hynes was a co-recipient of the 1997 Gairdner Foundation International Award.

Tyler Jacks received the 1997 American Association of Cancer Research Rhoads Award, and was named the first Daniel K. Ludwig Scholar at MIT.

Peter Kim was elected to the National Academy of Sciences.

Eric Lander was elected to the National Academy of Sciences, and received the 1996 Dickson Prize in Medicine from the University of Pittsburgh.

Uttam RajBhandary was named the Lester Wolfe Professor in Molecular Biology.

Robert Rosenberg was named the Whitehead Professor.

Sylvia Sanders was named an assistant investigator of the Howard Hughes Medical Institute.

Phillip Sharp was appointed a Member of the National Cancer Advisory Board by President William Clinton

Anthony Sinskey was elected a Fellow of the American Association for Advancement of Science.

Frank Solomon was elected Chair of the Education Committee of the American Society of Cell Biology.

Robert Weinberg received the 1997 National Medal of Science and was named the inaugural holder of the Daniel K. Ludwig Professorship for Cancer Research.

OTHER

During the past year, the Department established new industrial relationships. In January 1997 MIT and Merck & Company established a Research Collaboration Agreement which funds joint initiatives in both MIT science and engineering. Merck supports faculty and students in science and bioengineering in developing technology and research with funding up to \$15 million over an initial five year period, with an option to extend to 10 years. A corporate consortium consisting of Bristol-Myers Squibb Company, Affymetrix Inc. and Millennium Pharmaceuticals Inc. was established to fund a research program in functional genomics at the Whitehead Institute/MIT Center for Genome Research, headed by Professor Eric Lander. The new program will advance the development of gene-based technologies for research and health care and will provide funding of approximately \$8 million per year for five years. The MIT/Amgen Research Agreement, begun in 1994, provides for funding up to \$3 million a year for joint research initiatives and the collaborations continue to prosper.

The Department of Biology Corporation Visiting Committee met on November 6-7, 1996. Professors Phillip Sharp and Robert Sauer reported on major topics and issues for the future; Richard Hynes and Gerald Fink reported on the Center for Cancer Research and the Whitehead Institute, respectively; Professor Frank Solomon gave an overview of the graduate program and Professor Graham Walker reported on the undergraduate program. In addition, the members of the Visiting Committee had opportunities to meet with the faculty, graduate students and undergraduate students. The Department welcomed two new Visiting Committee Members, Dr. Hillary Nelson and Mr. Barry Weinberg, to their first meeting.

This June the Department held its second week-long intensive Short Course in Molecular and Cellular Biology for faculty in the School of Engineering. The course was taught by eight of the Biology faculty and included hands-on laboratory exercises. The purpose was to acquaint engineering faculty with the current state of knowledge, approach and issues in modern biology.

More information about this department can be found on the World Wide Web at <http://web.mit.edu/biology/www/>.

Phillip A. Sharp

DEPARTMENT OF BRAIN AND COGNITIVE SCIENCES

FACULTY RESEARCH DEVELOPMENTS

LEARNING AND MEMORY

Tomaso Poggio's lab continues to focus on the problem of learning at the level of theory, applications and neuroscience. During the last year, work on new classification techniques called Support Vector machines led to new theoretical results that establish a close relation between SVM and sparse representations of signals and images. Sparsity seems to be a key constraint in characterizing and discovering good representations for sensory signals. The new work on sparse representations has already led to the development of an architecture that can "learn" to perform rather difficult object detection tasks in images, such as detection of a person in a static image.

Matthew Wilson's laboratory successfully adapted multiple electrode recording techniques to the mouse and, in collaboration with Susumu Tonegawa's lab, completed a recent study characterizing neuronal activity in the hippocampus of the first tissue-specific genetic knockout animal. The characterization of a genetically altered animal lacking NMDA receptors within the CA1 sub-region of the hippocampus succeeded in demonstrating the relationship between synaptic plasticity and spatial memory. This combination of genetic, neurophysiological, and behavioral approaches promises to establish a firm link between molecular mechanisms of learning and memory and the processes of higher cognition.

In the past year, Earl Miller's laboratory has made several discoveries concerning the neural basis of working memory and its role in cognition. They identified prefrontal cortex neurons that integrate information about an object's identity ("what") and its spatial location ("where"). "What" and "where" are known to be processed separately in the visual system. Thus, these neurons may comprise a crucial link that allows actions to be directed toward objects.

Guosong Liu studies mechanisms of synaptic plasticity by examining the factors that regulate synaptic strength at single synapses. In particular, modulation of the number and properties of glutamate receptors can play a fundamental role in the process of synaptic plasticity. He showed that the average response size at multiple synaptic sites of a single neuron is remarkably constant, while the average size at single synapses varies four-fold across different cells, decreasing with increasing synaptic innervation. Recent data suggests that the difference may be due to differential expression of glutamate receptor subtypes.

VISION

Edward Adelson's research in visual motion perception has utilized a set of novel illusions to study the rules by which information is combined across space to constrain the interpretation of moving contours. He finds that junctions -- the place where contours meet -- offer important information, and that many phenomena can be explained by assuming that the visual system is using a Bayesian approach to estimating motion. A large pool of existing psychophysical data can thus be understood in a simple framework; this approach also offers powerful tools for segmentation of video sequences by machine vision.

Mriganka Sur's laboratory has shown that even the earliest stages of visual cortex -- primary and secondary visual cortex -- process not only simple visual stimuli but also complex images such as illusory contours. Neurons in these areas respond to the orientation of illusory contours and are organized into systematic modules that respond best to a particular stimulus orientation.

Barton Anderson's lab has focused on two types of problems in visual psychophysics. One problem involves the segmentation of images along occluding contours; the other involves the segmentation of images into a layered representation of surface causes. There has been substantial empirical and theoretical progress in both of these domains in the lab within the past year, including the understanding of computational principles underlying layered image representation. This work has led to a series of experimental discoveries that reveal the generality of the theory.

NEURAL AND COGNITIVE DEVELOPMENT

Gerald Schneider's laboratory, in collaboration with Susumu Tonegawa, made an important breakthrough in research on regeneration of severed nerve fibers in the mammalian brain. Their work uncovered a key role of the proto-oncogene *bcl-2* in promoting the growth and regeneration of axons. When transcription of this gene is down-regulated in the developing retinal ganglion cells, the large majority of the axons of these cells lose their ability to re-grow after injury. But, if an animal is genetically altered so the Bcl-2 protein is produced by the neurons of older mouse pups, then the loss of regenerative capacity does not occur.

Elizabeth Spelke's recent studies have focused on the development of object representation, spatial memory and number. Concerning spatial memory, she is investigating the spatial representations used by 1.5 to 2- year old children to determine their own position. Their studies reveal (a) a close homology between the representations guiding reorientation in young children and in other mammals such as rodents, and (b) a developmental change in human spatial representations, whereby the distinct representations guiding the young child's navigation become interconnected, permitting more flexible, and distinctly human, spatial performance.

LANGUAGE

Kenneth Wexler's research on early inflectional/grammatical development has been expanded to include many new phenomena, including Specific Language Impairment (SLI). He has found evidence for the heritability of tensing behavior, perhaps the first evidence in normal children for the heritability of a particular aspect of grammatical variation. A new development concerns evoked potentials: the lab has shown for the first time that a distinct module of grammar, binding theory, elicits a P600 "syntactic" violation signature, lining it up with more simple P600 violations. Moreover, and strikingly, a syntactic binding violation yields a P600, but a non-syntactic "pragmatic violation does not.

Steven Pinker published the results of a project on neural dissociations between grammatical computation and lexical lookup. Regular suffixation of "-ed", is rule-governed and freely extended to new verbs (e.g., "fax-faxed"), so it must be computed by a mental rule of grammar; irregular inflection is unpredictable (compare "sink-sank" with "think-thought") so the forms must be memorized in the mental dictionary. Examination of patients with distinct neurological syndromes points to a substrate for grammatical processing in a procedural system located in basal-ganglia/frontal-cortex circuits, and to a substrate for lexical memory in a declarative memory system located in limbic/posterior-cortex circuits.

Edward Gibson has proposed a major new theory of the relationship between working memory and human language comprehension: the Syntactic Prediction Locality Theory (SPLT). The SPLT starts with the hypothesis that the human language processor is a predicting machine: It predicts the categories that are necessary to complete the current input string as a grammatical sentence. There is a memory cost associated with each of these predictions, so the more predictions there are at a particular point, the harder it is to process at that point. Although the structure of languages is highly variable cross-linguistically, current evidence suggests that the SPLT applies uniformly across all languages.

EDUCATION

Of the 15 Ph.D.s granted in the last year, 11 have postdoctoral positions, and the remainder will be doing research in industrial settings. Applications to the program have been consistently increasing in quality and number and 12 new students were accepted from a pool of 196.

Several new graduate courses have been created, including: Neurology, Neuropsychology and Neurobiology of Aging, Molecular and Cellular Mechanisms of Neuronal Communication, Mechanisms of Synaptic Transmission and Plasticity, Evolutionary Psychology, and Cognitive Artifacts and Architectures. In addition, the department's graduate students organized a mandatory course on ethics. Topics covered included: obligations and responsibilities of the publicly funded scientist, ethical issues involved in mentoring, use and abuse of animals and humans in research, intellectual and patent rights, ethics of the peer review and grant processes, ethical issues in the gathering of data, and ethical issues in the publication of data.

The number of majors has increased, as has the number of students who elected to concentrate or minor in Psychology. A marked increase was also noted in the number of UROPS who were being paid or working for credit. In addition, a new undergraduate course in the neuroscience track was implemented.

FACULTY HONORS AND AWARDS

Barton Anderson: NIH Shannon Award

Peter Dayan: Surdna Junior Faculty Award

Earl Miller: NIH First Award
Whitehall Foundation Fellowship

Steven Pinker: Linguistics, Language and the Public Service Award from the Linguistics Society of America

Tomaso Poggio: Member, Daimler-Benz Circle Member Group
Elected to the American Academy of Arts and Sciences (1997)

Elizabeth Spelke: Elected to the American Academy of Arts and Sciences (1997)

Hermann Steller: Appointed Investigator, Howard Hughes Medical Institute

Mriganka Sur: Teuber Scholar in the Brain Sciences
McDonnell-Pew Visiting Professor, Oxford University

Kenneth Wexler: Editor's Award, Best Paper on Language, JOURNAL OF SPEECH & HEARING

Matthew Wilson: Middleton Neurosciences Award

Richard J. Wurtman: 32nd Annual Waldo E. Nelson Lecturer, Philadelphia, PA

Emilio Bizzi, M.D.

DEPARTMENT OF CHEMISTRY

In the 1996-97 academic year, the Chemistry Department continued its strong program in undergraduate and graduate education and research. The department currently has 25 active faculty, over 61 postdoctoral researchers, 205 graduate students and 124 undergraduate majors.

The Chemistry Department has initiated a major program to renovate 90,000 square feet of laboratory space, targeted in Chemistry Campaign 2000". This plan aims to bring the department's research space up to the standards of the 1990's. The goal is to raise \$15M over three years and to complete renovations by the year 2000. Thus far we are ahead of our schedule and have secured pledges, including commitments from the Institute, approaching \$13M. Included are funds from the Pfizer Corporation and Pfizer Foundation totaling \$1M to create the Büchi/Pfizer Laboratories of Synthetic Organic Chemistry and a \$0.5 M grant from duPont for creating new laser laboratory facilities. The department initiated a program of Industrial Internships for graduate students. Intended to enhance the student's research experience as well as providing exposure to an industrial environment, the first internship will begin in the summer of 1997.

HIGHLIGHTS OF THE YEAR

Appointment of Molina as Institute Professor, election of Ceyer to the NAS and Tannenbaum to the NIM, and securing a large portion of our infrastructure campaign pledges.

Professor Mounji Bawendi was the recipient of the Coblenz Award and awarded the School of Science Teaching Prize and was named Keck Professor of Energy.

Professor Stephen Buchwald was named holder of the Camille and Henry Dreyfus Chair in Chemistry.

Professor Sylvia Ceyer was elected to the National Academy of Sciences.

Professor Christopher "Kit" Cummins was awarded an Alfred P. Sloan Research Fellowship.

Professor John Essigmann was awarded a MacVicar Fellow and a School of Science Teaching Prize.

Professor Gregory Fu was named as the Firmenich Professor of Chemistry, received a Dreyfus Teacher/Scholar prize, received an Alfred P. Sloan Fellowship and was awarded one of the first three Glaxo Wellcome Chemistry Scholars Awards.

Professor Robert Field received an honorary doctorate from Amherst College.

Professor Daniel Kemp received an Arthur C. Cope Award from the American Chemical Society.

Professor Satoru Masamune received the Fujihara Award from Japan.

Professor Mario J. Molina was named Institute Professor and elected to the National Institute of Medicine.

Professor Larry Stern was selected as holder of the Pfizer/Laubach Career Development Chair.

Professor Jamie Williamson was awarded a Camille and Henry Dreyfus Teacher/Scholar Award.

Professor Steve Tannenbaum was elected to the National Institute of Medicine.

RESEARCH

Bob Field observed for the first time the spectroscopic signature of bond-breaking isomerization in an eigenstate resolved spectrum in the molecule HCP (homologous to HCN, but spectroscopically more tractable).

Jun Liu found the target protein for two related anti-angiogenesis drugs, AGM-1470 and ovalicin.

Irwin Oppenheim developed the first satisfactory mode coupling formulation for glass transitions.

JoAnne Stubbe proposed a new model for how one molecule of bleomycin, a clinically useful antitumor antibiotic, can cleave double-stranded DNA without dissociating from the double helix.

Professor Jamie Williamson was promoted to Associate Professor with tenure.

Professor Daniel Nocera of Michigan State University joined the faculty in July 1997 was appointed as Full.

Professor. Dr. Jeffrey Simpson was hired as the Director of the Spectroscopy Laboratory and Ms. Cheryl Eccles accepted a position in the Physical Education Department.

DISTINGUISHED VISITORS AND LECTURERS

The Chemistry Department was privileged to host the following distinguished scientists in endowed lectureships during the past academic year:

- Professor Ivano Bertini from the University of Florence was the A.D. Lecturer in Inorganic Chemistry in December of 1996.

-
- Professor Dr. Gerhard Ertl from the Fritz-Haber Institute of the Max-Planck was the Arthur D. Little Lecturer in Physical Chemistry in May.
 - Professor Stuart Schreiber from Harvard University was the T.Y. Shen Distinguished Lecturer in Biological Chemistry in December of 1996.
 - Professor K. Barry Sharpless was the George Büchi Visiting Lecturer in Organic Chemistry in March 1997.
 - The Procter and Gamble Symposium on Neurochemistry was held on February 11, 1997, and Professors Dennis Dougherty from Caltech, Roger Tsien from U. C., San Diego, and Michael Marletta from the University of Michigan were the guest speakers.
 - The second annual Siemens/MIT Symposium on Crystallographic Chemical Analysis was held in January to celebrate the use of X-ray diffraction as a first resort analytical tool for the elucidation of chemical structure.

STUDENT ACTIVITIES

In the Fall of 1996, the Department admitted 29 students to the graduate program. From September of 1996 to June of 1997 the Department awarded, 5 Masters and 38 Ph.D degrees. At the Senior Recognition Dinner in May, awards in chemistry were announced at the Department's Senior Recognition Award in May of 1997- seniors who are recipients of **1997 Undergraduate Chemistry Awards: The Alpha Chi Sigma Award** for recognition of academic achievement and contributions in research and/or service to the department was awarded to Jennifer Sokol and Junko Tamiya. **The American Institute of Chemists Award**, presented in recognition of a demonstrated record of ability, leadership, and professional promise was awarded to Lillian Chong, **The Merck Index Award** was presented to three seniors in recognition of outstanding academic achievement: Annie Lee, Doris Lin and Srivatsan Raghavan. **The Chemistry Undergraduate Research Award** was given to Lillian Chong and Jennifer Sokol. **The Chemistry Undergraduate Service Award** awarded in recognition of outstanding service to the field of Chemistry and to the department went to Raylene Sanchez. **The Undergraduate Teaching Award** for outstanding teaching in the field of chemistry by an undergraduate went to Federico Bernal, Hisham Eissa and Lily Huang. Zoltan Maliga was awarded the **Hypercube Scholar Award**.

The following chemistry majors were noted for their work as educators, both at MIT and in the community elementary schools: **Teaching:** Federico Bernal, Hisham Eissa, Pat Huang, Lily Huang, Sean Lavin, Zplatan Maliga, Michael Marino, Kenneth Mills, John Modzelewski, Georgiana Rivers, Timothy Shiau and Junko Tamiya; **Tutoring:** Songpon Deechongkit, Christina Eng, Wendy Jen, Suhail Mithani, Georgina Rivers and Jason Wong. **The Chemistry Magic Show:** Joshua Bittker, John Gavenonis, Jennifer Lee and Timothy Shiau. **Graduate Awards:** Christopher Morse of the Davison Group was awarded a 1997 Goodwin Medal;

Industrial Internship Program: The M.I.T. Chemistry Department 's internship program placed it's first intern for the summer of 1997 and is moving forward to encourage graduate students to spend a brief period in the laboratory of an industrial collaborator. Graduate students and faculty supervisors will have the choice of a number of companies and projects from which to choose, and individual faculty and students are particularly encouraged to propose additional possibilities based on their interactions with specific companies. A typical internship assignment would be three months during the Summer semester, although other times and duration may be considered.

Stephen Lippard

DEPARTMENT OF EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

Research and education within the Department of Earth, Atmospheric and Planetary Sciences (EAPS) engage a broad array of scientific disciplines: geology, geophysics, geochemistry, physical and chemical oceanography, meteorology, atmospheric chemistry, and planetary sciences. Particular emphasis is placed on the study of the complex geosystems in the Earth's atmosphere, ocean, crust, and deep interior and the similar systems on other planets. The Department comprises 42 faculty, including one with a primary appointment in Civil and Environmental Engineering, 221 graduate and undergraduate students, and 115 permanent research staff, postdoctoral appointments and visiting scholars.

EDUCATIONAL ACTIVITIES

During the past academic year, 185 graduate students were registered in the Department (Course 12) and the MIT-Woods Hole Oceanographic Institution (WHOI) Joint Program (Course 12W). The EAPS graduate program currently focuses on the Ph.D. degree, which is the goal of over 90% of its graduate students. There is a growing need, however, for professionals trained at the master's level who can solve geoscience problems in a broad, systems-oriented context. In response to this need, EAPS has developed a new degree program, which will award the Master of Science in Geosystems beginning this next academic year. This S.M. degree is designed to appeal to students seeking careers in industry as professional geoscientists, as well as working professionals who wish to expand their knowledge and opportunities in geoscience. It will prepare students for scientific and management careers in the environmental, natural resources, and technical consulting industries by providing skills in computer simulation and modeling of complex natural systems, as well as in scientific inference based on field observations and numerical modeling. A second major educational initiative has been the establishment of the Program in Atmospheres, Oceans and Climate (PAOC), which coordinates graduate study in atmospheric science, oceanography, and climate physics and chemistry. The Program, which replaces the Center for Meteorology and Physical Oceanography (CMPO) as the administrative unit in atmospheric sciences and oceanography, offers a broadly based curriculum for students interested in studying climate at the system level, and in performing research in oceanography and atmospheric science.

EAPS is continuing efforts to improve the quality and scope of its undergraduate program. The bachelor of science curriculum has been reorganized 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/or laboratory subjects, and independent study or thesis preparation. An undergraduate minor degree program has also been developed to complement degrees in other disciplines, providing a foundation for careers that incorporate areas of geoscience. The Department has expanded its Independent Activities Program (IAP), and EAPS now offers more IAP courses for credit than any other MIT department. The Department continues to increase its participation in freshman advising seminars, and this past year, EAPS faculty advised over 10% of the freshman class. EAPS has maintained a strong Undergraduate Research Opportunities Program (UROP), despite changes in federal regulations that have increased the cost of UROPs to grants and contracts.

FACULTY

Professor Thomas Herring was promoted to Full Professor. Professors Chris Marone, Jochem Marotzke and Maureen Raymo were promoted to Associate Professor without tenure. Professor Kip Hodges was appointed Dean for Undergraduate Curriculum.

The highlight of an exciting year was the announcement that Nobel Laureate and EAPS Professor Mario Molina was named Institute Professor. Professor Jack Wisdom was appointed the Breene M. Kerr Professor. Professor Robert van der Hilst was awarded the James B. Macelwane Medal, and Professors Van der Hilst and Frederick Frey were elected Fellows of the American Geophysical Union.

CURRENT RESEARCH

GEOLOGY AND GEOCHEMISTRY

Professor Samuel Bowring's work on the Acasta gneisses continues, and he has documented rocks as old as 4.03 Ga. A 4.0-Ga tonalite contains inherited zircons that are as old as 4.06 Ga. This pushes back the age of the oldest crustal rocks on the planet, and indicates that older crust plays a role in the generation of tonalitic magmas. In addition, the

work of Professor Bowring and his group has dramatically altered the time scale for early animal evolution. The new time scale for the middle and upper Cambrian will allow paleontological correlation of trilobites at the level of Jurassic ammonites. Through his research in central Nepal, Professor Kip Hodges is establishing the complex relations between east-west extension in the Tibetan plateau and north-south shortening in the Himalaya. Recent results suggest that the link may be a system of extensional faults that have operated as dissipative structures for the Himalayan orogenic system for at least 20 million years. Professor Tim Grove and his colleagues have been studying disequilibrium processes in earth materials by measuring solid state diffusion rates in common mantle minerals. They find that diffusion rates for trace elements are much slower than previously believed, and that diffusion rates vary systematically among rare earth elements by a factor of 30. These measurements provide new constraints on melting mechanisms, and on the behavior of trace elements during basalt magma production. Professor Fred Frey has been studying the ~115 m.y. record of volcanism attributed to the Kerguelen hot mantle plume located in the southern Indian Ocean. Based on the efforts of Frey and colleagues, the Ocean Drilling Program has scheduled a two month drilling program in 1998 that will sample the igneous crust of the Kerguelen Plateau.

Professor Clark Burchfiel is continuing his studies on the nature of intercontinental deformation within active plate boundary settings. In collaboration with Professor Leigh Royden and Principal Research Scientist Bob King, combined geologic, geodetic and geodynamic modeling has led to a new interpretation for the formation of the Tibetan plateau that focuses on thickening of the crust in the eastern part of the plateau by lateral flow of weak lower crust. Studies in African/Eurasian convergent zone with Royden, King and Principal Research Scientist Rob Reilinger have shown that extensional tectonism reaches north of the North Anatolian fault into central Bulgaria, Macedonia and Albania and must be considered the northern part of the Aegean extensional regime. Professor John Southard, in collaboration with Professor John Grotzinger, is extending his work on sediment gravity flow deposition, looking further into the poorly understood rapid deposition of structureless sediment by powerful turbidity currents by means of high-speed cinematography. Professor Kelin Whipple is currently engaged in field studies (Sierra Nevada, Himalayas, and E. Tibet) and numerical modeling of river profiles and their response to tectonic uplift. He is also constructing a new flume in the Sediment Laboratory for experimental study of debris-flow hazards.

GEOFYSICS

Professor Chris Marone's recent work has focused on friction constitutive laws and earthquake faulting. He has demonstrated a connection between shear-band width within laboratory faults and the stability of sliding, explaining why faults do not begin to strengthen immediately during the postseismic period, with important implications for earthquake nucleation size and stress drop. Professor Brian Evans is working on specifying constitutive laws for multi-phase rocks using theories developed for ceramic matrix composites. The results of experiments and modeling using a modified Eshelby-Morii-Tanaka theory indicate that the surprisingly large strengthening achieved by adding quartz particles to a calcite matrix must be accompanied by a paradoxical increase in interphase boundary sliding next to the quartz particles. Senior Research Scientist Peter Molnar has been pursuing convective instability of a lithosphere layer undergoing mechanical thickening due to horizontal shortening. Results are allowing Molnar and his colleagues to estimate amounts of lower lithosphere removed by such a process and the elapsed times required for it to occur.

Professor Bradford Hager and colleagues have developed a technique for spatial spectral localization of data on a sphere and have used it to quantify the signature of Laurentide deglaciation in Earth's gravity field. The mantle viscosity structure that fits the gravity signature, as well as the observed relaxation times for uplift beneath Hudson Bay and Fennoscandia, is substantially more viscous in the upper mantle than Professor Hager's models for tectonically active regions, consistent with the existence of the continental tectosphere. Professor Thomas Herring has been working to characterize the refractive properties of the Earth's atmosphere as applied to precise geodetic positioning applications, and to laser altimeter from Earth orbiting satellites. Professors Herring and Hager, and Principal Research Scientist Robert King have been active in the geodetic efforts of the Southern California Earthquake Center. The MIT group has played a prominent role, both in estimating the velocity field in southern California from existing GPS data and in developing the scientific justification for the newly-funded initiative to install > 200 continuously operating GPS receivers in the Los Angeles area. Professor Daniel Rothman has initiated new studies of the physics of granular media. The most important result thus far is a new model for vibrated sand that explains recent experimental observations of localized excitations.

Professor Robert van der Hilst and colleagues have finalized the processing of seismic data related to global earthquake activity between 1964 and 1995 and have used the vastly improved data for tomographic imaging of Earth's interior structure. The new images strongly suggest the continuation of many slabs of subducted lithosphere into the lower mantle, possibly to the core mantle boundary, which swings a decades old convection debate in favor of a circulation model that involves mantle wide overturn. Professor Marcia McNutt spent the first few months of her sabbatical year as a guest of the Universite Francaise du Pacifique in Tahiti helping the government assess their marine resources using satellite altimetry data. Her research has concentrated on documenting major continent-ocean differences in the viscosity structure of Earth's upper mantle to depths as great as 700 km.

Professor Dale Morgan and his students have completed environmental geophysics field studies at the Oak Ridge National Laboratory, the Massachusetts Military Reservation, and the Aberjona Superfund. Professor Morgan also successfully predicted, with three days warning, the largest seismic event in a swarm of earthquakes in Tobago. Professor Nafi Toksöz and his research group have developed a method of detecting fractured intervals in oil and gas reservoirs using seismic reflection data. These methods may help unlock vast US natural gas reserves, which are difficult to identify and produce. Principal Research Scientists Robert Reilinger and Robert King, Research Scientist Simon McClusky, and Professor Toksöz are coordinating two projects that use GPS measurements to map crustal deformation, one in the Eastern Mediterranean and the second in Southern California. These studies will provide constraints on lithospheric rheology and dynamics in plate collision zones, and will quantify fault slip for earthquake hazard studies. Professor Thomas Jordan, graduate student Rafi Katzman, and postdoctoral fellow Li Zhao have used new tomographic techniques to image small-scale convection in the upper mantle of the central Pacific Ocean. The pattern they have discovered indicates that the three major Pacific hotspots of Hawaii, Tahiti, and Marquesas are controlled by this upper-mantle convection, and that their associated topographic swells are underlain by high seismic shear velocities, an unexpected result with important geodynamical implications.

PLANETARY SCIENCE

Professor Jack Wisdom is continuing his studies of the dynamical evolution of the solar system. Recent work has focused on the evolution of the Earth-Moon system. He has found that the Earth-Moon system passed through strong orbital resonances early in its evolution, which may resolve a long standing inconsistency between lunar formation scenarios and previous dynamical histories of the Earth-Moon system. Professor Maria Zuber and colleagues have used a General Circulation Model to analyze the nature of atmosphere-cryosphere mass exchange over seasonal cycles on Mars. Results indicate that ice deposition in the polar regions should produce a detectable change in the planet's gravity field, and time varying gravity analysis represents a new method for measuring seasonal variations of the planet's CO₂ inventory. Professor Zuber's laser experiment was successfully launched on the Mars Global Surveyor spacecraft in November, 1996, and will arrive at Mars in September, 1997, and will map the planet's global topography for two Earth years.

Professor Richard Binzel has utilized ground based telescopes to investigate the compositional properties of asteroids passing near the Earth and has discovered numerous source bodies for the most common class of meteorites, the ordinary chondrites. Professor Binzel's continuing Hubble Space Telescope observations of the second largest asteroid (530 km diameter) Vesta have revealed an enormous 400 km impact basin, containing a 13 km high central peak, in the vicinity of the south pole. Color measurements of the basin suggest the exposure of the olivine upper mantle on this small planetary world. From a recent stellar occultation by Neptune's moon Triton, Professor Elliot and colleagues find that Triton's atmosphere is unexpectedly distorted from spherical symmetry, most likely indicating the presence of strong winds that are comparable to the sonic velocity of 140 m s⁻¹. Professor Counselman developed a new kind of antenna for satellite geodesy, which distinguishes between radio waves arriving directly from the sky and waves reflected from the ground. This antenna promises to improve substantially the accuracy and speed of crustal-motion measurements. Principal Research Scientist Heidi Hammel has published an analysis of Hubble Space Telescope imaging of Neptune focusing on the stability of large-scale structures in the planet's atmosphere. She has also initiated a study of the atmosphere of Uranus and has continued follow-up studies of Jupiter since the collision of Comet Shoemaker-Levy 9, again using Hubble imaging.

OCEANOGRAPHY

Professor Jochem Marotzke has investigated the consequences of the observed enhanced mixing near the ocean margins on the large-scale ocean circulation. Numerical experiments have guided the formulation of the first published theory linking convective activity and the climatically important thermohaline circulation and its associated heat transport. Together with Principal Research Scientist Detlef Stammer and collaborators at MIT, he

has computer generated the adjoint to the recently developed MIT ocean general circulation model, which provides unprecedented flexibility in model-sensitivity and data-fitting studies. Professor Carl Wunsch, working with Stammer and in collaboration with other members of the physical oceanography group, have begun producing three dimensional estimates of the global ocean circulation every few days. The work involves combining meteorological surface conditions, satellite altimetry and a general circulation model into a consistent picture of the time evolving ocean. Professor Paola Malanotte-Rizzoli and collaborators have been modeling the ocean's circulation in different regions using data assimilation to improve the models. She has started a collaboration for the study of tropical/subtropical interactions through assimilation of TOPEX altimetry and is also investigating the physical/biochemical dynamics of the Eastern Mediterranean and the Black Sea ecosystems in the context of multinational collaborative programs. Professor Glenn Flierl is conducting research on the relationship between the meandering of the Gulf Stream and the mean recirculations on either side, and on the dynamics of jets as they detach from the coast. He is also studying vortices in the ocean, in the Jovian atmosphere, and in the solar nebula including the role such flows might have in encouraging dust accumulation and planet formation. Professor John Marshall and his group have continued to develop climate modeling capability by exploiting atmosphere-ocean fluid isomorphisms to create, by leveraging off their previous work in ocean modeling, a coupled atmosphere-ocean model with a common hydrodynamic kernel. Hierarchies of coupled models are now being used to study aspects of middle and high-latitude atmosphere-ocean coupling designed to reveal possible mechanisms of decadal climate variability of phenomena such as the North Atlantic Oscillation.

Professor Edward Boyle has completed a study of the climate of the last interglacial period (130,000-115,000 years ago) for the subtropical western North Atlantic. This study shows that although the climate during most of this period was relatively stable in contrast to some reports based on Greenland ice cores, there is an abrupt century-scale event near the end of the period (118,000 years ago). Deep water chemistry indicates reduced North Atlantic Deep Water formation and a tripling of clay fluxes, marking the onset of neoglaciation. Professor John Edmond continues his work on the geochemistry of the big rivers of Eastern Siberia, and is extending work to the rivers and lakes of Central Asia. He is also working to establish the sources of dietary iodine, whose deficiency afflicts ~25% of the world's population with clinical symptoms. Professor Maureen Raymo and her collaborators have been studying a wide range of paleoclimate problems, including the cause of the eccentricity cycle in global ice volume, the impact of climate change on deep sea benthic diversity, and the climate conditions under which rapid variations in ocean thermohaline circulation occur.

ATMOSPHERIC SCIENCE

Professor Mario Molina and his research group have determined the reaction rate and the branching ratio for HCl formation in the radical recombination reaction $\text{ClO} + \text{OH}$ using the high-pressure turbulent-flow technique developed in their laboratory. The measurements indicate a 5% HCl yield, with important implications for the understanding of the chemistry of the stratosphere, particularly at higher altitudes. The mechanism of the $\text{SO}_3 + \text{H}_2\text{O}$ reaction to form sulfuric acid was further elucidated, confirming that the reaction rate is second order in H_2O , and that the reaction has an unusually large negative activation energy (~13 kcal/mole). The thermodynamics and nucleation rates for the formation of acid hydrates from ternary $\text{H}_2\text{SO}_4/\text{HNO}_3/\text{H}_2\text{O}$ solutions was further investigated using a variety of experimental techniques, including infrared spectroscopy and optical microscopy involving micron-sized droplets that simulate polar stratospheric cloud particles. The results are important for the elucidation of the role of stratospheric clouds in ozone depletion. Professor Ronald Prinn and his colleagues recently reported very good news regarding the ozone layer. Measurements over the past 18 years from the Advanced Global Atmospheric Gases Experiment showed that the total chlorine contained in long-lived man-made chlorofluorocarbons and chlorocarbons reached a maximum value in the lower atmosphere in 1992, and began to decrease through 1996. This implies that ozone depletion by these gases is maximizing around the present time and that phase out of these chemicals is proceeding somewhat faster than demanded by the Montreal Protocol. Professor Reginald Newell flew on the NASA P3-B aircraft in a mission to measure tropospheric ozone and associated trace constituents in the southeast Pacific. One unusual finding was of high ozone, characteristic of the lower stratosphere, in a stalactite-like tropical upper tropospheric area, which had been predicted from satellite observations.

Professor Peter Stone and his colleagues have completed the development of a new flexible climate model, specifically designed for use in studies of uncertainty in projections of global climate change. The model's representations of cloud processes and of mixing of heat into the deep ocean can be varied, thus making it possible for the model to reproduce the wide range of projections that have been made with the most sophisticated climate models, but the new model is computationally two orders of magnitude more efficient. Professor Kerry Emanuel spent two months at the National Centers for Environmental Prediction, running a field experiment designed to test the concept of

adaptive sampling of the atmosphere, under a grant with Professor Ed Lorenz. He is also working on optimizing convection schemes for climate research, using field experimental data. Professor Edmund Chang investigated the properties of baroclinic waves in the atmosphere and mapped out the wave guides in which these waves preferentially propagate with maximum coherence. He also found that these wave packets, unlike individual waves, can stay coherent for an extended period of time, sometimes in excess of two to three weeks. He is currently working on applying these results to improving medium-range forecasting. Professor Dick Lindzen and colleagues have begun an examination of satellite and terrestrial data of various types in order to ascertain the possibility of direct measurement of climate sensitivity to various perturbations including increased levels of atmospheric carbon dioxide. Preliminary results suggest the absence of unique results for short-term perturbations with possible convergence over the long term. He is also examining seasonal cycles in anthropogenic gases to ascertain the relative importance of tropospheric and stratospheric transport. Professor Alan Plumb and colleagues have developed a new stratospheric transport model, based on the concept of a "tropical pipe" within which upwelling takes place, using data from the Upper Atmosphere Research Satellite to specify the circulation. His research group has also continued investigations of a wide range of problems in atmospheric dynamics.

More information about this department can be found on the World Wide Web at the following URL: <http://www-eaps.mit.edu/>

Thomas H. Jordan

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 1996-97, there were 156 undergraduates majoring in mathematics, 120 in Course XVIII, Mathematics, and 36 in Course XVIII-C, Mathematics/Computer Science. Bachelor of Science degrees, including double majors, were awarded to 69 students, 58 in Course XVIII and 11 in Course XVIII-C.

There were a total of 93 graduate students in mathematics, all in the Ph.D. program. This year 20 students received the doctoral degree and 2 received the master's degree.

FACULTY CHANGES

Professor Ehud Hrushovski resigned from MIT for a faculty position at Hebrew University. Associate Professor Ezra Getzler and Assistant Professor Sheldon Chang also resigned from MIT.

Dr. Lucia Caporaso will join the Department as an Assistant Professor. Specialized in algebraic geometry she comes from Harvard University as a Benjamin Pierce Assistant Professor and Sloan Research Fellow. Dr. Lars Hesselholt has also accepted an Assistant Professorship offer. He has been a CLE Moore Instructor at MIT for the last three years and is specialized in algebraic topology.

Assistant Professor Bonnie Berger was promoted to Associate Professor of Applied Mathematics. Her specialties are in algorithmic theoretical computer science and in computational molecular biology.

HONORS, PRIZES AND AWARDS

Professor Emeritus Bertram Kostant was bestowed an honorary Doctor of Science degree by Purdue University.

Professor George Lusztig received an Honorary Doctorate degree from the University of Paris VII for his work on representation theory.

Professor Franklin Peterson received a Reinvitation Award from the Alexander von Humboldt Foundation for three months of research support at the University of Heidelberg. This reinvitation follows a similar award from 1991-93.

Professor Gian-Carlo Rota was conferred the Doctor Honoris Causa from the New York Polytechnic Institute.

Assistant Professor Bonnie Berger was selected for a Samuel A. Goldblith Career Development Professorship for a three year period. This professorship is named after Professor Samuel Goldblith, a distinguished MIT scientist in the field of applied biology.

Graduate student Konstanze Rietsch was awarded an Alfred P. Sloan Doctoral Dissertation Fellowship.

Graduate student Ioanid Rosu received the Housman Graduate Student Teaching Award, which is given to a graduate student in mathematics who has demonstrated exceptional skill and dedication to teaching.

Graduate student Andras Vasy was selected for the first Charles W. and Jennifer C. Johnson Prize for an outstanding research paper accepted in a major journal by a graduate student in mathematics. The title of the paper is "Structure of the Resolvent for Three-Body Potentials;" it will appear in the *Duke Mathematical Journal*.

In the summer of 1996, six mathematics graduate students participated in the Research Sciences Institute Program, a national program offering select high school students six weeks of research experience. Of the nine research projects mentored by our graduate students, one was selected as a finalist and two as semi-finalists in the Westinghouse National Talent Search Program.

In the Putnam Intercollegiate Mathematics competition, five MIT undergraduates ranked among the top 25 students out of an approximate total of 2500 participants. The MIT team of three undergraduates placed seventh in the competition.

Seniors Pramod N. Achar and Aleksey Zinger were awarded the Jon A. Bucsela Prize in Mathematics in recognition of distinguished scholastic achievement. Among those seniors awarded degrees in mathematics, four were elected to the national honor society Phi Beta Kappa.

ADMINISTRATION

Professor Michael Artin will resume as Chairman of the Undergraduate Committee after a leave of absence, during which Professor David Vogan served, and David Vogan will succeed Professor Daniel Stroock as Chairman of the Pure Mathematics Committee. Professor Hung Cheng will continue as Chairman of the Applied Mathematics Committee, Professor Richard Melrose as Chairman of the Graduate Committee, and Professor James Munkres as Chairman of the Committee of Advisors.

EDUCATIONAL

Among the educational initiatives of the department, here are the ones that involve the undergraduate core.

Two calculus offerings introduced in the past few years have proven increasingly attractive. Most MIT freshmen have had calculus in high school, and about half place out of 18.01 Calculus (single variable). For many of the rest, the pace of 18.01 Calculus is too slow. For these students the Department offers a sequence 18.01A & 18.02A Calculus, taken by more than 200 students last year (compared to 160 in 18.01 Calculus). It covers the 18.01 material in the first half of the fall term, and then begins with the 18.02 material at the standard pace. Students can complete 18.02 Calculus either in an intensive course during IAP (the most popular choice) or in the first half of the spring semester. Separating these better-prepared students has also made it possible to aim 18.01 Calculus more directly at students with little or no calculus background. For some students who do receive 18.01 credit, the standard fall semester 18.02 (several variable calculus) is a bit too fast-paced. For those students we offer 18.02S; this alternative had about 120 students last fall, compared to 350 in 18.02 Calculus.

Two smaller versions of calculus (18.014 & 18.024, Calculus with Theory, and 18.023, Calculus with Applications) continue to serve the students well.

We are continuing the experiment, now a year and a half old, of increasing the number of weekly recitation hours from one to two in 18.03 Differential Equations. Since the annual enrollment in 18.03 is about one thousand, this is quite a difficult experiment for the teaching staff. The success we seek—most of all a stronger connection between students and their recitation instructors—is not easy to measure, but we have been pleased with the results.

The Department's practice teaching program, supervised by Professor Haynes Miller, is now required for our graduate students, and is available to new instructors as well. In this program, Teaching Assistants are put into a classroom situation before they are assigned a recitation of their own. We are also continuing the videotaping program organized many years ago by Professor Arthur Mattuck; all new teaching staff are videotaped during their first semester, and Professor Mattuck provides detailed comments on the tapes.

More information about the Mathematics Department can be found on the World Wide Web at the following URL: <http://www-math/hq/links/html>.

David J. Benney

DEPARTMENT OF PHYSICS

During the past year, the Physics Department maintained its position as a leader across the frontiers of physics research. A flavor of these activities is given in the brief accounts later in this report and in the more detailed reports from laboratories with significant physics participation. On the academic side, the department's strong commitment to its educational program was demonstrated in classroom instruction, curricular innovation, and research mentorship.

The members of the Physics Department continue to provide leadership for major MIT interdepartmental laboratories. Currently, the Directors of the Laboratory for Nuclear Science (LNS), Bates Linear Accelerator Center, Center for Space Research (CSR), Center for Materials Science and Engineering (CMSE), Plasma Fusion Center (PFC), and Harrison Spectroscopy Laboratory are members of the Physics Department, as well as the Associate Director of the Research Laboratory of Electronics (RLE). In addition, Professors Robert J. Birgeneau and J. David Litster serve as Dean of the School of Science and Vice President for Research and Dean for Graduate Education, respectively. In 1995-96 the total number of faculty was 76. Samir Mathur and Bolek Wyslouch were promoted to Associate Professor without tenure; Lisa Randall was promoted to Associate Professor with tenure, and Wolfgang Ketterle, Leonid Levitov, and Paraskevas Sphicas were promoted to Professor. Faculty on leaves or sabbaticals during this year included: Aron Bernstein, Bruno Coppi, Edward Farhi, Jeffrey Goldstone, Roman Jackiw, John Joannopoulos, Henry Kendall, Richard Milner, Ernest Moniz, John Tonry, Rai Weiss, and Barton Zwiebach. Xiangdong Ji and Pawan Kumar left MIT for positions elsewhere.

The physics faculty garnered numerous awards and honors. Professor Jerome Friedman, who stepped down as Interim Head of the Department at the end of January, was elected Vice President of the American Physical Society (APS) and will become President in 1999. Professor Robert Birgeneau received the 1997 IUPAP International Magnetism Award. Professor John Joannopoulos was awarded the APS David Adler Lectureship. Professor Henry Kendall has been named winner of the APS 1997 Nicholson Medal for Humanitarian Service. Professor Wolfgang Ketterle received the APS I. I. Rabi Prize. Professor Daniel Kleppner was awarded the Oersted Medal. Professor Toyo Tanaka was recognized with a 1996 R & D 100 award. Professor Samuel Ting received the China International Science and Technology Award from the Chinese government. Professors Joannopoulos and Craig Ogilvie shared the Department's 1996 Buechner Prize for excellence in teaching, while Professors Tomas Arias and Edward Farhi won School of Science Teaching Prizes for undergraduate and graduate education, respectively. Professors Arias and Takashi Imai received Alfred P. Sloan Foundation awards. Several faculty were awarded chairs in recognition of outstanding contributions to the Department and Institute: Wit Busza (Friedman Chair), Claude Canizares (Rossi Chair), John Joannopoulos (Davis Chair), Paul Schechter (Burden Chair), and Toyo Tanaka (Morningstar Chair).

The Department hosted two major events: the National Conference of Black Physics Students and the United States Particle Accelerator School.

EDUCATION

The Department continues to maintain a large number of undergraduate and graduate students and credit units per faculty member. This year the number of undergraduate majors was 155, the number of minors was 2, and the number of graduate students was 259. The number of degrees awarded totaled 50 S.B., 5 S.M., and 45 Ph.D.

The introductory physics subject 8.01 was taught in its new format, in which the primary instruction takes place in small classes, for a third year. A departmental committee was appointed to evaluate the course, based on the three years' experience with the new format. By and large, the participating faculty are enthusiastic about this format, but the approach does place significant demands on our staffing of other courses. A decision will be made in January, 1998 as to whether the new format will be continued in future years.

To sustain the high quality of physics teaching at all levels with fewer faculty, we are slightly reducing our course offerings in ways that do not reduce the breadth of opportunity but do reduce student flexibility. For example, the subjects Quantum Theory I and II will each be offered in only one of the two semesters; Junior Laboratory will be reduced from four to three sections; small increases in recitation class sizes will be implemented selectively.

The planned increase in the number of graduate teaching assistants over the next years will allow the Department to address these problems.

8.01L, the "long" version of 8.01 intended for students with less preparation in physics and mathematics, continues to be well-received. Individual tutoring for each student is an important component. The enrollment has grown steadily over the five years in which the course has been offered, from about 60 to over 150 this past year.

As part of the new curriculum for majors, the course Quantum Theory III (8.059) was taught for the first time. The expanded quantum theory sequence incorporates numerous applications of quantum mechanics to physical systems. A new IAP course, Advanced Project Laboratory (8.122), was oversubscribed, an issue to be addressed in the upcoming year.

Our recently introduced interdisciplinary courses continue to be successful: Biological Physics (8.515J), in collaboration with Health Sciences and Technology, and Fluid Physics (8.292J) in collaboration with EAPS. A new course entitled "Entropy, Information, and the Brain" will be offered in IAP 1998.

Many students entering MIT with Advanced Placement for 8.01 have been found to be disadvantaged in 8.02 with respect to peers who have completed 8.01. Accordingly, the Department has raised the standard for "placing out" of 8.01.

CURRENT RESEARCH

The range of high quality forefront basic research activities pursued by the MIT physics faculty is unmatched at any other physics department. This is reflected in the large number of Institute laboratories and centers which support substantial research programs of the Physics faculty. The reports from the Laboratory for Nuclear Science (including the Bates Linear Accelerator Center and the Center for Theoretical Physics), the Center for Materials Science and Engineering, the Research Laboratory of Electronics, the Center for Space Research, the Plasma Fusion Center, the Harrison Spectroscopy Laboratory, and the Haystack Observatory should be consulted for a more complete description of some of these research programs. We can provide only a brief overview in the space made available here.

ASTROPHYSICS

Research in Astrophysics deals with our attempts to understand the universe on the largest scales. Phenomena ranging from planets around nearby stars to accreting black holes in the Milky Way to quasars and clusters of galaxies at cosmological distances are studied. Observational programs involve the collection, analysis, and interpretation of data from a wide variety of ground-based and space-based observatories. Theoretical research is carried out on a similarly wide range of topics that often complement the observational program.

X-ray astronomy continues to be a major area of research. The Rossi X-Ray Timing Explorer satellite, containing an all-sky monitor developed at MIT, has been operating since December 1995. Of particular interest has been the discovery of quasi-periodic oscillations at frequencies in excess of 1000 cycles per second. These are interpreted as the orbital frequencies of material in Keplerian orbits close to the surfaces of neutron stars. With the launch of the Advanced X-ray Astronomy Facility (AXAF) scheduled for summer 1998, considerable effort has gone into planning the observations.

The search for and exploitation of gravitational lenses are major activities at both radio and optical wavelengths. The difference in light travel time as measured from optical flux variations of the images in one lens system has been used to measure the distance to the lensing galaxy, yielding a one step measurement of the Hubble constant that skips the many rungs of the cosmological distance "ladder." In a parallel effort, several new lenses have been discovered.

Other optical programs include followup work on X-ray sources, in particular candidate black holes. Programs such as these will benefit greatly from the Magellan project. Construction of the enclosure and structure for the first telescope have been completed. First light is expected in early 1999 with the completion of the first mirror.

Work continues on LIGO (laser interferometer gravitational wave observatory). Construction is well underway, and it is anticipated that the LIGO observatory will be operational by the year 2000. Development work is underway for a second generation detector.

The MIT Plasma Science Experiment on board Voyager 2 will be the first spacecraft to escape the heliosphere and directly measure plasma conditions in the interstellar medium. A plasma experiment on the WIND satellite is part of the International Solar Terrestrial Physics program designed to study the nature of solar-terrestrial interactions.

Numerical calculations of the dynamical evolution of systems of planets are being carried out, with the goal of explaining newly observed patterns of planet masses and distances which are very different from those observed in our solar system. Theoretical studies continue on the formation and evolution of binary systems containing collapsed stars, especially the newly discovered class of "supersoft" X-ray sources. Hydrodynamic calculations of stellar collisions and mergers are also being carried out. Collisions explain anomalous stars seen in dense star clusters while mergers are potentially detectable sources of gravitational waves.

Numerical simulations of cosmic structure formation, including the use of large N-body simulations, and high precision calculations of microwave background fluctuations are being extensively investigated.

ATOMIC PHYSICS

MIT has one of the three groups world wide that has been able to observe Bose-Einstein condensation in a gas of ultra-cold alkali atoms. The MIT group has been amazingly productive, and in the last year has achieved record densities of condensed atoms, observed the normal modes of oscillation of the condensate, developed a non-destructive technique for imaging the condensed and uncondensed atoms in the trap, and studied the interactions between two separate clouds of condensed atoms. Their latest work demonstrates the coherent nature of groups of atoms released from the trap, the first realization of an "atom laser."

BIOLOGICAL AND MEDICAL PHYSICS

The objective of this program is to apply the intellectual approaches and experimental techniques of modern physics to real problems in medicine and biology. Two examples illustrate how this can be done.

Alzheimer's disease is associated with the precipitation of the amyloid β -protein in plaques which interfere with the transmission of signals in the nervous system. A method of light scattering spectroscopy has been developed which allows a detailed quantitative study of the growth of amyloid β -protein aggregates. Experiments in different environments have led to a specific model for the kinetics of the growth mechanism.

On the theoretical side, advanced techniques in statistical mechanics have been used to model some simple but fundamental aspects of visual perception, specifically those associated with pattern and orientation recognition.

CONDENSED MATTER PHYSICS

Research in this area is aimed at understanding the new physical phenomena which manifest themselves in the bulk states of matter. The following are some highlights from the past year.

Studies of the two-dimensional electron gas, in particular in the quantum Hall and fractional quantum Hall regimes, are still at the forefront of condensed matter research. An experimental study of tunneling into the gas at its boundaries has revealed an unexpectedly rich structure in the edge states of the gas. Subsequent theoretical work has been able to explain many of the features in terms of Bragg scattering of the incoming electrons from quasi-periodic modulations in the two-dimensional electron density perpendicular to the boundary.

Work on "Bucky Balls," the soccer ball shaped C_{60} molecule, has advanced to the fabrication of "Bucky Tubes," long hollow cylinders of ordered carbon atoms only about 40 angstroms in diameter. The exact winding pattern of the carbons about the cylinder has profound effects on the electron transport down the tubes, effectively changing them from conductors to insulators. The details of the relationship between nanostructure and electrical properties are being studied both experimentally and theoretically. Practical applications of these unique materials are being investigated.

Nano-technology is advancing at such a rate that it may soon be possible to make structures such as beams with cross sections only tens of atoms across. Under these circumstances the properties of the beam, such as strength and elasticity, will depend not only on the bulk crystal structure, but on the particular surface structure (surface reconstruction) that might occur for these small dimensions. A study is under way to use *ab-initio* theoretical structure calculations to determine what surface reconstructions might occur for specific materials such as silicon, and to predict the resulting mechanical properties.

One of the unique features of the new high temperature superconducting materials is the presence of isolated layers of copper oxide in which the magnetic moments on the copper ions form a nearly perfect two dimensional Heisenberg antiferromagnet. In a new series of experiments involving a variant of these materials (containing extra Cu^{2+} ions) the layers are used as a "test bed" for studying novel magnetic effects. A specific magnetic geometry is set up in which the leading terms in the magnetic interactions cancel, exposing higher order terms which lead to subtle magnetic behavior. This behavior is similar to that involved in "spin ladder" geometries but allows the determination of important parameters unmeasured in those geometries.

Modern *ab initio* wavefunction calculations carried out on large computers have had a great deal of success in explaining the structures of molecules and solids. These techniques have now been applied to clusters of molecules in a study of how a single excess electron forms metastable complexes with groups of water molecules. Specific structures are identified that correlate well with the observed behavior of electrons immersed in liquid water. Moreover, the study has given insight into the generic electrophilic nature of the dangling H atoms in water clusters. This insight can add to our understanding of electron transport in complex biomolecular systems.

NUCLEAR PHYSICS

The goal of research in nuclear physics is to understand at a fundamental level the structure and behavior of strongly interacting matter, ranging from terrestrially observed hadrons and nuclei to new forms of matter that may be created experimentally or observed astrophysically.

Several experimental initiatives have been undertaken to discover new states of matter by colliding relativistic heavy ions. A systematic study of nucleus-nucleus collisions using gold beams at the BNL AGS is examining the energy dependence of collision products for signatures of new phenomena, and another BNL experiment has produced upper limits on the production of fragments rich in strange quarks. Measurements of pion production at CERN's heavy ion facility have now been completed and place a significant upper limit on the production of a novel excited state of the vacuum known as a disoriented chiral condensate. The PHOBOS detector, presently being constructed under MIT leadership, will be one of the first detectors to explore the new high energy regime at RHIC and will provide a unique window on novel collective phenomena. To fully exploit these emerging opportunities, a theorist recognized for seminal ideas in relativistic heavy ion physics has recently been recruited.

Electron scattering research includes measurements of the neutron charge and magnetization distributions, studies of quasi-elastic scattering from nuclei at high momentum transfer, and the use of parity violation as a novel probe of proton structure. The MIT led Hermes experiment at DESY, using polarized electrons on a polarized Helium-3 target, is producing data revealing the spin structure of the neutron. The recent DOE approval of the BLAST spectrometer opens the way for unique experiments on polarized gas targets to explore spin physics at Bates. Extensive theoretical calculations of the effects of relativistic corrections and final state interactions in the scattering of polarized electrons from polarized nuclei enable the quantitative analysis of current experiments at Bates and TJNAL and provide valuable guidance in planning future experiments.

A major focus of theoretical research is the numerical solution of QCD on a discrete space-time lattice, which provides the only known way to calculate the structure of hadrons and the thermodynamic properties of the quark-gluon plasma from first principles. Recent developments include a powerful new formulation of the theory analogous to quantum spin systems and a renormalization group method for dramatically reducing artifacts associated with the finite lattice. Lattice calculations have provided insight into the essential role that topological excitations of the gluon field play in hadron structure, and current calculations include the distribution of quarks in the nucleon and the properties of exotic six-quark states. The recent donation of a 24 Gigaflops cluster of symmetric multiprocessors will greatly enhance lattice calculations and the ongoing collaboration with the Laboratory for Computer Science to advance high performance scientific computing.

PARTICLE PHYSICS

Researchers in particle physics seek to extend and unify our understanding of the fundamental constituents of matter and the theory that governs them.

The very successful Standard Model of Particle Physics has been tested by detailed studies of the Z particle using the L3 detector at LEP. Meanwhile data acquisition has begun at the upgraded LEP2 collider, which will provide collisions above the W^+W^- threshold. An exciting new result is the preliminary determination of the non-Abelian weak boson self-coupling g_{ZWW} .

Collisions of protons and antiprotons at the highest energies have been studied with the CDF at Fermilab. After obtaining the first direct evidence for the existence of the elusive top quark, the CDF team is now carefully studying its mass and decay modes. CDF is also providing important new information on the production and decay of bottom quark-antiquark (b - \bar{b}) pairs. Analysis techniques developed in this experiment offer the possibility of the first measurements of CP violation in the b - \bar{b} system. In addition, the MIT group is involved in both the ATLAS and CMS detector initiatives for the Large Hadron Collider (LHC) program under development at CERN.

Using polarized electrons and the SLD detector at SLAC, experimenters have taken a first look at the left-right cross-section asymmetry for Z production, and have checked the predictions of the Standard Model for heavy quark production and decay.

An experiment led by MIT scientists to study the flux of antimatter in cosmic radiation using a permanent magnet spectrometer on a space vehicle (space shuttle/station) is now under construction, for a first launch in 1998.

A novel search for the axion, a particle that has been posited to solve the so-called 'strong CP problem' of Quantum Chromodynamics and serendipitously is a candidate for the solution of the dark matter problem of astrophysics, has been mounted in a collaboration with Livermore and others. After a year of data collection this experiment has yielded its first publication of an upper limit on the coupling of axions to photons.

Recent research in particle physics theory has led to a number of advances, including important progress on the problem of black hole radiation. Although Hawking developed a semiclassical theory of black hole radiation over 20 years ago, the absence of a true theory of quantum gravity has prevented physicists from going beyond this approximation. Fundamental questions, such as the ultimate fate of the information that falls into a black hole, have remained unanswered. Theorists are now hopeful, however, that the riddle of quantum gravity has been solved by a new approach called string theory, which offers a complete description of both matter and gravity with no free parameters. Recently an MIT theorist (with collaborators) showed that string theory leads to a successful microscopic description of low-energy Hawking radiation, reproducing the semiclassical results both for the emission rate and the angular momentum distribution.

Since string theory reduces to traditional quantum field theory at low energies, it can be used to analyze the properties of field theory. An MIT researcher (in collaboration) has uncovered strong evidence that some of the exciting dualities (i.e., exact equivalences between seemingly disparate theories) recently found in quantum field theories can be understood as low-energy consequences of string theory symmetries.

String theory implies that the behavior of bosons (particles of integer spin) is connected to the behavior of fermions (particles of half-integer spin) by a relationship called supersymmetry, a relationship which is also motivated by other lines of reasoning. Since the masses of bosons do not match the masses of fermions, however, this symmetry must be dynamically broken. MIT researchers have been active in formulating detailed models of how this can happen.

MIT theorists have also been pursuing the use of the early universe as a complement to accelerator experiments in testing particle theory ideas. Recently they have developed, and are pursuing, a new version of inflationary cosmology based on the underlying particle physics of supersymmetry breaking.

PLASMA PHYSICS

The restructuring of the U.S. fusion program will leave MIT's new plasma fusion machine, Alcator C-Mod, as one of only two large research tokamaks in the program. In the few years since it was commissioned, C-Mod has proven to be an extremely versatile research tool. Most recently, it was used to demonstrate a novel new method for heating plasmas. When there are two ion species in a magnetized plasma, a resonance exists between the two ion cyclotron frequencies due to collective effects in the plasma. Having a resonance in the plasma offers a unique opportunity for efficient absorption of incident electromagnetic wave power, with a concomitant heating of the plasma. The predicted behavior was verified in C-Mod for two different ion species and magnetic fields. Since the exact location of the absorption in the plasma can be controlled, this technique will ultimately allow control of the plasma pressure and current profile.

Ernest J. Moniz

CENTER FOR LEARNING AND MEMORY

The Center for Learning and Memory was established in May 1994 as an interdepartmental research center between the Department of Brain and Cognitive Sciences and Department of Biology. The Center's primary research interest is to study the mechanisms underlying learning and memory using multifaceted approaches. Susumu Tonegawa was appointed as the first Director of the Center in May 1994. Matthew A. Wilson joined as an Assistant Professor on July 1, 1994. William G. Quinn who has been a faculty member in Department of Brain and Cognitive Sciences since July 1, 1994 joined the Center on April 1, 1995. Guosong Liu and Earl Miller joined as Assistant Professors on September 1, 1996.

RESEARCH BY CENTER SCIENTISTS

Dr. Susumu Tonegawa's laboratory developed a novel genetic technology with which researchers can knockout a gene in specific neurons in the hippocampus, namely CA1 pyramidal cells. They applied this technology to an NMDA receptor gene and produced a mutant mouse strain in which this gene is deleted exclusively in the CA1 pyramidal cells. By analyzing these mice by brain slice electrophysiology and by behavioral methods, they obtained strong evidence for the notion that synaptic plasticity underlies spatial learning.

Dr. Matthew A. Wilson's laboratory analyzed the CA1-specific NMDAR1 knockout mice by their multiple electrode recording technology applicable to freely moving rodents. They discovered that in these mutant mice, the coordinated activity of ensembles of CA1 neurons specific to the animal's locations (called place fields or place cells) is drastically impaired. These findings, when combined with the findings made in Tonegawa's laboratory (see above), constitute the first cohesive description of molecular, cellular, and neuron ensemble mechanisms for a specific cognitive function, namely spatial memory.

Dr. Earl K. Miller's laboratory made an important discovery regarding our ability to integrate the "what" and "where" information of objects. What and where are known to be processed separately in the visual system. Dr. Miller's laboratory identified prefrontal neurons that respond to both types of information of an object. These neurons may comprise a crucial link that allows actions to be directed toward objects.

Dr. William G. Quinn's laboratory has made substantial progress on two major projects - molecular cloning of the *radish* gene and development of a strong selection scheme for new learning mutants.

The *radish* mutation is crucial to the understanding of memory storage processes because it eliminates one of two forms of long-term memory -- consolidated or amnesia-resistant memory -- while sparing the other (protein-synthesis dependent memory). Dr. Quinn's laboratory has positionally mapped the *radish* gene to a 140-kb interval on the *Drosophila* X chromosome, and they have cloned the DNA in this interval. They are currently isolating and sequencing cDNAs corresponding to mRNA transcripts from this interval. The sequence of one transcript is intriguing -- it encodes an mRNA binding protein, possibly a splicing factor. Other sequenced transcripts have high homology to mouse mRNA, currently unknown of function.

Selecting learning and memory mutants is currently tedious and unreliable. It requires breeding and behavioral screening of groups of identical, mutagenized flies. However, Quinn's laboratory has selected new (clonable) alleles of one learning mutant based on partial suppression of the female sterile phenotype of another learning mutant, *dunce*. Aberrant cyclic AMP signaling in mutant *dunce* flies apparently affects both behavior and ability. The memory mutation *amnesiac* partially suppresses the female sterility of *dunce*, apparently by metabolic compensation. They are now engineering a more pronounced aberration in the cyclic AMP metabolic pathway to produce more severe female sterility for tighter selection screens. Initial engineering results on this project are very encouraging.

In Dr. Guosong Liu's laboratory, the overall research objective is to study how synaptic activities regulate the strength of interconnections between neurons in the central nervous system and what role activity plays in the process of synapse formation, elimination, and consolidation. Previously, they have studied the mechanism of synaptic transmission and synaptic plasticity in single synapses, as well as synapse formation and regulation during early development, using gene knockout animals and transfection in cultured neurons.

INTERACTION WITH OTHER DEPARTMENTS

Dr. Susumu Tonegawa and Dr. David Baltimore jointly organized a weekly informal discussion group among faculty members from the Department of Biology, the Department of Brain and Cognitive Sciences, and the Whitehead Institute who are interested in neurobiology and neuroscience. Ten to twenty faculty members joined each week and were engaged in very lively discussions on various topics in brain research.

Susumu Tonegawa

GEORGE R. HARRISON SPECTROSCOPY LABORATORY

The George Russell Harrison Spectroscopy Laboratory is engaged in research in the field of 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. An Interdepartmental Laboratory, the Spectroscopy Laboratory encourages participation and collaboration among researchers in various disciplines of science and engineering. Professors Feld, Steinfeld, Mounji G. Bawendi, Robert W. Field, Daniel Kleppner, Keith A. Nelson, Stephen J. Lippard, Jeffrey I. Steinfeld, Toyochi Tanaka, Steven R. Tannenbaum 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 (LRF) provides resources for core research programs in the physical sciences for 13 MIT Chemistry and Physics faculty. Information about the equipment and facilities of the LRF and the LBRC can be found in the Spectroscopy Laboratory Researcher's Guide.

RESEARCH HIGHLIGHTS

Professor Field and Dr. Steven Coy have developed a powerful pattern recognition technique, extended spectral cross-correlation, to extract patterns (relative intensities, energy splittings) repeated in two or more spectra without any prior knowledge of the nature of the patterns or even the number of repeated patterns present. Using this technique, complete information has been extracted from the dispersed fluorescence (DF) spectrum of acetylene about the early time ($t < 1\text{ps}$) dynamics of a "Franck-Condon bright state" on the electronic ground state potential surface, at all energies up to $16,000\text{ cm}^{-1}$ above the zero-point level.

Professors Field and Steinfeld have initiated a spectroscopic study of the isocyanogen $\text{N}\equiv\text{C}-\text{N}\equiv\text{C}$ molecule to observe the $\text{NCNC}\rightarrow\text{NCCN}$ isomerization process in the DF and/or stimulated-emission-pumping spectrum. Our initial spectroscopic goal is to record the electronic spectrum of NCNC in the ultraviolet region (250nm), first by direct absorption and then by cavity ringdown spectroscopy.

Professor Field and Dr. Steven Drucker are developing methods for studying triplet electronic states of small, unsaturated hydrocarbon molecules (e.g. acetylene). Triplets are long-lived energetic species that often play an unsuspected role in photochemical processes. Our first complete prepare-probe-detect apparatus for triplet spectroscopy has been designed, and the experiments are in progress.

Professors Steinfeld and Field and their students are investigating the use of advanced optical techniques for atmospheric monitoring. They have recently demonstrated that backscattered light preserves the phase information necessary for FM detection. Strong backscattered FM signals were observed from molecular iodine at a vapor density of $10^9\text{-}10^{10}\text{ cm}^{-1}$, suggesting that FM-based remote sensing could be a sensitive and versatile technique for measuring atmospheric trace gases. The addition of FM capability to pulsed lasers used in atmospheric remote sensing promises a considerable enhancement of sensitivity in comparison to the traditional differential absorption lidar. By using a frequency modulated pulse, the absorber distribution could be obtained directly in the FM-detected response from a single pulse. Moreover, since the amplitude of the FM signals is approximately proportional to the ratio of ω_r to linewidth, relatively sharp molecular absorption lines (pressure broadened at 1 atm to 5 GHz, or 0.1 cm^{-1}), may be readily distinguished from the near-continuous background attenuation due to particulate scattering or molecular aggregates. This technique can be extended into the ultraviolet and mid-infrared regions, where key atmospheric trace gases such as methane, non-methane hydrocarbons, and nitrogen oxides can be detected.

Professor Bawendi is using a picosecond laser and time-correlated photon counting to study the electronic properties of semiconductor quantum dots and heterostructures containing those dots. Data on dilute samples of dots have been used to develop models of relaxation mechanisms and fine structure in the electronic transitions. Time-resolved studies of the heterostructures (close packed arrays of dots) have been used to study and understand energy transfer between dots. Professor Bawendi has also developed a new apparatus to study the spectroscopy of individual quantum dots. His group has found that the linewidths are ultranarrow ($<0.120\text{meV}$), a result which has

important implications for the physics and applications of the materials. They have also begun to study Stark effects of individual dots, which is important for any device application that uses dots and electric fields to modulate light.

Professors Marc Kastner and Bawendi studied charge transport in close-packed dot heterostructures. They used the picosecond apparatus to study the temperature dependence of charge separation dynamics following photoexcitation.

Professor Lippard and his associates have used Raman spectroscopy to investigate the reactions of dioxygen with diiron (II) and dicopper (I) complexes as models for metalloenzyme active sites. The O-O stretching frequencies of the resulting peroxo-bridged dimetallic complexes were measured and used to characterize the species present. Fluorescence resonance energy transfer studies were also carried out to investigate the interactions of high mobility group domain proteins with cisplatin-modified DNA containing pendant fluorescent donor and acceptor molecules.

Professor George Benedek and Drs. Jayanti Pande and Manoharan have investigated molecular changes in the protein crystallin and eye lens using Raman spectroscopy. Oxidative stress, which leads to a variety of non-enzymatic modifications in crystallins, is the major cause of cataract formation. The intensity of S-S and S-H stretching modes in Raman spectra has shown that sulfur centered oxidative dimerization occurs in crystallins

Professor Tannenbaum and Drs. Paul L. Skipper, Dasari and V. Bhaskaran Kartha have analyzed and quantified levels of benzo[*a*]pyrene (BP) adducts in samples of human serum albumin and human lung histone proteins using the ultrasensitive HPLC with laser-induced fluorescence detection system. Human albumin samples from 100 volunteers have been analyzed, with 17 samples showing BP adducts ranging from 0.05 to 4.8 fmol adduct per mg of albumin. Another 145 albumin samples and 35 lung histone samples remain to be analyzed to complete a comprehensive epidemiological study.

Professor Alexander Rich and Drs. Imre Berger, Dasari and Manoharan have demonstrated the specificity of human double-stranded RNA deaminase enzyme for left-handed Z-DNA using Raman spectroscopy. Raman spectra of B-DNA/Z α -peptide complex exhibit characteristic Z-DNA peaks at 627 and 1318 cm^{-1} , which are not observed in either B-DNA or Z α -peptide. The occurrence of these bands in the B-DNA/Z α -Peptide complex shows that poly d(GC) DNA adopts a Z-DNA conformation and binds to the Z α -peptide. This study provides the first direct evidence for the actual existence of left-handed DNA in the protein-DNA complex.

Professor Ali Javan's research has focused on the resistance vs. voltage characteristics (RVC) and optical response of superconductor-normal metal Point Contacts (SNPCs). SNPCs are the simplest means of constructing nanoscale conductance paths between a bulk super conductor and a metal. Novel RVC features measured on these SNPCs have been shown to result from flow of critical current in the SNPC. The optical response has been used in a new technique to measure superconductor relaxation rates in real time.

Professor Kleppner and his students have extended our understanding of the connections between quantum mechanics and classical motion by their new technique of recurrence spectroscopy in a microwave field. Periodic orbits in their system, a Rydberg atom in an electric field, can be identified from the Fourier transform of the spectrum. They found that by applying microwave fields near resonance with the periodic orbits, the intensity of the recurrences was systematically modified in a fashion that could be related to the detailed motion of the corresponding classical system. These results illustrate one case in which quantum mechanics can describe detailed classical motion.

Professor Feld and Drs. Dasari and Kyungwon An have studied the single-atom microlaser, a fundamental laser device with a single atom as the gain medium. Recent progresses include demonstration of a traveling-wave atom-cavity interaction in the microlaser and development of a precision spectroscopic technique to measure mirror absorption at sub-ppm levels using thermally induced optical bistability.

Professors Tanaka and Feld and Drs. Kartha and Dasari studied spectroscopies of gels near phase transitions. Random heteropolymers are known to be in three phases: swollen, collapsed but fluctuating, and collapsed and frozen in a conformation. The third phase, which is considered to be responsible for the stability and memory of conformation of proteins, was found in copolymer gels, where major interactions are hydrogen bonding. The degree of hydrogen bonding is being studied using FT-IR and Raman spectroscopy.

Professor Feld and Drs. Dasari, Geurt Deinum, Irving Itzkan, Manoharan, and Lev Perelman pursued basic and applied applications of lasers in biology and medicine. Reflectance, fluorescence and near-IR Raman spectroscopy

were used for biochemical analysis of tissues and blood, and diagnosis of dysplasia, cancer, atherosclerosis and other diseases. Clinical studies were pursued with researchers from the Cleveland Clinic Foundation, Brigham and Women's Hospital, Metrowest Hospital and New England Medical Center in colon, Barretts' esophagus, bladder, breast and coronary and peripheral arteries. Quantitative analysis of blood analytes using Raman spectroscopy is under development. Observation of the nuclear signatures in reflectance spectra lead to a new technique for measuring nuclear size distribution in biological tissues. UV resonance Raman spectroscopy was used to characterize dysplasia. Photon migration using a newly developed time-resolved optical tomographic system was used to image small fluorescent objects (lesions) imbedded in turbid biological tissue in the presence of background fluorescence, and to study paths of early arriving photons. Finally, the mechanism of pulsed laser ablation of soft and hard biological tissues was shown to be thermoelastic in origin. The experimental and theoretical work being conducted in this program is advancing new laser diagnostic technologies in the field of medicine.

More information about the Laboratory can be found on the World Wide Web at <http://web.mit.edu/spectroscopy>.

Michael S. Feld

GEORGE R. WALLACE, JR., ASTROPHYSICAL OBSERVATORY

The George R. Wallace, Jr., Astrophysical Observatory is a teaching and research observatory located in Westford, Massachusetts. Its facilities consist of a 24-inch telescope, a 16-inch telescope, several 14- and 8-inch telescopes, a 5.5-inch astrograph, and a building that houses a workshop, darkroom, computer facility, and observers' quarters. Instruments used during the past year include a portable high-speed CCD occultation system, several small CCD systems, conventional photometers, photographic cameras, and a high-resolution spectrograph. The SNAPSHOT high-speed dual-CCD photometer, in service since 1984, has been retired and plans are being formulated for a modern replacement. Work is continuing to improve the optics of the 24-inch telescope, and a low-resolution spectrograph has been prototyped for the smaller telescopes.

Professor James Elliot continued his duties as Observatory Director. Principal Research Scientist Heidi Hammel assisted with site management and telescope scheduling, with the help of Research Specialist Richard Meserole. Mr. Michael Person has served as a part-time Technical Assistant for making observations, helping with observatory maintenance and training students. Steve McDonald continued his part-time work on software and computer management. Other staff (usually students) are coordinated through research programs. Undergraduates working on the spectrograph project (Lisa Kwok) and instrument design (Paul Collins) participated in NSF's Research Experiences for Undergraduates (REU) program, as did the summer students (Shaïda Bouramand, Adam Einarsen, Edgar Gonzalez, Lorraine Hertzog, Eric Nielsen, Rosa Villastrigo).

Last year, course 8.287J-12.410J (Observational Techniques of Optical Astronomy) drew 14 students, who used the Wallace facilities for a variety of astronomical projects, including observations of the total lunar eclipse that occurred in September, 1996. An additional 32 students in subject 12S23/12.409 (Observing the Stars and Planets, the first subject number distinguishes first-year vs. upperclass registrants) used the Observatory for laboratory work. Informal field trips were offered for courses 12.401 (Beyond the Solar System; 14 students) and 12S22 (Hands-on Astronomy; 8 students), as was an observing session for freshmen last fall. An open house held during MIT's 1997 Independent Activities Period attracted over 30 people (mostly undergraduates, though faculty and staff from other departments came).

Mr. McDonald, Mr. Person, and the summer students used the 24-inch to obtain astrometric CCD data for Pluto, Neptune's moon Triton, and the stars fields through which they will move during the next decade. These data will be used to identify stars that these bodies will occult so that observations can be carried out with telescopes that would happen to lie in the path where an occultation will be visible. These occultation candidates will be of particular importance for NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA—a 747SP that will house a 2.5-m telescope and begin operations in 2001), which can get to the center of virtually any occultation path. The occultation data will be used to investigate how the thin N_2 atmospheres of Pluto and Triton respond to changes in season and distance from the sun.

Prof. Elliot, Dr. Hammel, Mr. Collins, and Mr. Einarsen collaborated with Prof. Schechter in beginning the design of a CCD camera for the Magellan telescopes in Chile for which MIT has a 10% share of the observing time. The instrument would permanently occupy a Nasmyth port on one of the telescopes and would be always accessible for opportunity observations (such as supernovae and occultations) and synoptic observations that require only a small amount of time per night. Hence Prof. Schechter has dubbed the instrument MANIAC (MIT Auxiliary Nasmyth Instantly Accessible Camera).

Meg Golden and Mr. Person carried out CCD imaging observations of Comet Hale-Bopp during the fall and spring, using filters selected to isolate the dust and ion tails of the comet. They also participated in a cooperative effort to observe a stellar occultation by the comet in the western US in October, 1996.

Mr. McDonald, Mr. Person, and students initiated a program to search for large, slowly moving objects that may be part of the Kuiper Belt population in the outer solar system, and Dr. Slivan continued a project of imaging objects from the Messier Catalog.

James L. Elliot

EXPERIMENTAL STUDY GROUP

For the past twenty-eight years, the Experimental Study Group has provided a unique educational alternative to the regular curriculum for first year students at MIT. Learning is based on the concept of self-motivated study through small interactive groups, tutorials, independent projects, and seminars. Students have found this approach beneficial for a number of reasons: the opportunity to work closely with instructors and be able to ask questions, the chance to be part of a close-knit academic program with a strong community focus, and a flexible structure which allows students to study material at their own pace and depth.

STUDENT STATISTICS

The total number of students for the year included 53 freshmen and 23 upperclassmen who had been in ESG as freshmen. In addition, 31 undergraduates who had not previously been in ESG enrolled in seminars and HASS subjects taught in ESG.

Fifty-one percent of ESG's freshman class were female, eight percent were underrepresented minorities, and twenty-one percent were international students. The 49 sophomores currently registered at MIT who had been in ESG as freshmen earned a cumulative median grade point of 4.4, a figure which is higher than the corresponding figure for the entire sophomore class at MIT.

ADMINISTRATION

Professor Vernon Ingram (Director of ESG) and Dr. Holly Sweet (Associate Director) administered and monitored program offerings and activities. Renee Hoffman joined the staff in April as an administrative assistant. Dr. Sweet also participated actively in the MIT Academic Administrators' Re-engineering Team and co-facilitated an experimental ten session professional development group for academic administrators.

The ESG advisory committee met with Professor Ingram and Dr. Sweet during the year to supervise the academic portion of ESG. The committee is headed by Professor Alan Davison (Department of Chemistry), and includes Dean Robert Birgeneau (School of Science), Dean Philip Khoury (School of Humanities and Social Sciences), Professor Ernest Moniz (Department of Physics), and Professor Alar Toomre (Department of Mathematics).

STAFF AND FACULTY

The physics staff included Professor Emeritus Robert Hulsizer and Robert Halfman, Dr. Peter Dourmashkin (Lecturer), Craig Watkins (Lecturer), and David Custer '82 (Lecturer). The mathematics staff was headed by graduate student Thomas Colthurst and included graduate student Adam Lucas and Mr. Watkins. The chemistry offerings at ESG were supervised by Christopher Morse, a graduate student in the Department of Chemistry. The biology staff was headed by Professor Ingram and included Cindy Limb, who tutored biology and maintained the biology wet lab.

ESG also offered several HASS and HASS-D courses to its students. Dr. Lee Perlman taught 21L001 Foundations of Western Culture in the fall term and SP2H1 Philosophy of Love in the spring term. Mr. Custer taught 21W730 Expository Writing in the fall term and 21W735 Writing and Reading the Essay in the spring term.

Our staff was assisted by 36 undergraduate tutors (who maintained an impressive GPA of 4.6), and 13 graduate tutors. New undergraduate tutors were required to participate in a fall teaching seminar run by staff. Dr. Sweet interviewed all freshmen during the middle of each term about their academic progress and overall satisfaction with both ESG and MIT. Her recommendations, based on these interviews, were reviewed at the annual staff retreat in June. Several new ESG policies, based in part on these recommendations, were instituted, including distributing an ESG tutor training manual to all new tutors, and holding biweekly supervisory meetings for new graduate tutors.

ACADEMIC INITIATIVES

ESG continued to sponsor new academic initiatives, which were funded through a special grant given to ESG during the previous academic year by Dean Birgeneau. These initiatives included seminars on photography, information retrieval, eastern religions, psychology, drawing, computer programming, philosophy, and literature. Four of these seminars were developed and taught by undergraduate students under staff supervision. One seminar (information

retrieval) was co-sponsored by the Edgerton Center. Students and staff also worked on Hypertexts in molecular biology and mathematics.

AWARDS

Dr. Sweet and Dr. Perlman team-taught SEM051 (Sex Roles and Relationships) for the tenth year in a row. This seminar, based on a combination of theory and experiential work, was written up in the November/December 1996 issue of *Technology Review* and also won the 1997 Irwin Sizer award for "the most significant improvement to MIT education."

Mr. Morse won the 1997 Goodwin medal for "conspicuously effective teaching on the graduate level" for his work both in ESG and in the regular curriculum.

The ESG Hypertext in Molecular Biology, written by ESG students and Professor Ingram, has been recommended by a number of bodies, e.g. *The Chronicle of Higher Education*, *The AP Teachers*, *Student-net*, *Scout Report*, and others. It is widely used nationally and internationally by teachers and students.

FUTURE DEVELOPMENTS

ESG continues to support educational innovation in both teaching and learning. Funds were solicited from ESG alumni during June to raise money for new seminars, support on-going seminars, and continue work on the biology and math hypertexts. An annual teaching award for the best undergraduate tutor at ESG will also be funded by alumni contributions. We look forward to contributing to the educational mission of MIT by using our resources to encourage curricular and pedagogical experimentation by both staff and students at ESG.

V. Ingram, H. 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 1997, the Department of Energy is expected to provide LNS a total of \$29,686,000 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), Fermilab (Illinois), and Brookhaven (New York). 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 look explicitly for physics beyond the Standard Model. LNS researchers are playing leading roles in much of this research, as described below.

The L3 experiment at CERN is the largest of four detectors at the Large Electron Positron (LEP) Collider, which is the highest energy such collider in the world. The aim of the experiment is to deepen our knowledge of the Standard Model by measuring with high precision the properties of the intermediate vector bosons, Z and W, their couplings to other particles and, perhaps, the mechanism of spontaneous symmetry breaking. One is of course always keeping open the possibility of finding new phenomena beyond the Standard Model. This project has been led from the beginning by an LNS group, and broke new ground in bringing together a large number of scientists from many countries into a highly successful collaboration. Important recent L3 tests of the Standard Model include precise measurements of the properties of the Z^0 particle (the carrier of the neutral electroweak force); demonstration, by two independent methods, that there are only three types of light neutrinos in the Universe; limits on the possible mass of the Higgs boson; and the measurement of the strong coupling constant α . After a number of years of operation at the maximal Z^0 production energy, LEP is now running at energies high enough to produce large numbers of the W^\pm particle, the carrier of the charged electroweak force. This next stage of the L3 experiment is testing the Standard Model in an even more stringent fashion. An exciting new result is the preliminary determination of the non-Abelian weak boson self-coupling g_{ZWW} .

LNS researchers are playing a leading role in exploiting the unique properties of the SLD detector at SLAC. With micron size beams, very high resolution vertex detection, excellent particle identification and calorimetry, and a polarized electron beam, SLD is making important contributions to the precise determination of Standard Model parameters and to our understanding of heavy quark physics. Measurements of the left-right cross section asymmetry, A_{LR} , for Z^0 boson production using polarized electrons have yielded a determination of the effective weak mixing angle which is even more precise than the individual LEP results.

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 $\bar{p} - p$ collider. A recent highlight is the discovery of the top (t) quark, by far the most massive elementary particle ever seen. The MIT group played an important role in the data acquisition and analysis which led to this result. As the measured mass of the t quark has become more precise, this information combined with other results has begun to provide significant constraints on the mass of the undiscovered Higgs boson. Current objectives of CDF include studies of the b quark, the low mass partner of the t quark; precision measurement of the mass of the W; and the search for possible quark sub-structure.

An experiment to search for the axion, a particle predicted to exist as a minimal extension of the theory of strong interactions as well as a possible solution to the "dark matter" problem in cosmology, has yielded its first publication of an upper limit on the coupling of axions and photons. This experiment is the first to search for the axion in a physically interesting region with sufficient sensitivity to mean a discovery is plausible.

The "strangelets" experiment at Brookhaven now has a significant data set and information on the possible existence of this exotic form of matter is expected soon.

LNS is involved in both large detector initiatives at the Large Hadron Collider (LHC) project at CERN, 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 data acquisition and muon detection systems and expect to be major participants in the U.S. efforts at the LHC.

The Alpha Magnetic Spectrometer (AMS) project has made great strides recently. AMS will look for anti-matter and dark-matter candidates above the Earth's atmosphere, first with a Space Shuttle mission in 1998 and then with a long mission on the International Space Station beginning in 2001. This remarkable collaboration, led by LNS, involves researchers from many different countries as well as coordination between DOE and NASA. The very fast timescale for detector construction and testing is on schedule for delivery of the payload to Kennedy Space Center at the beginning of 1998.

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. A major upgrade of its capabilities, the South Hall Ring, has recently been completed. This upgrade allows both external and internal-target experiments using the continuous (as opposed to pulsed) beam from the Ring. The continuous nature of the beam is critical for a number of experiments, such as those using coincidence techniques. The opportunity to pursue internal target experiments, especially those involving polarized beam and polarized targets, maintains a unique and important position for Bates in the international community. A new detector (BLAST) for internal target studies has recently been funded by DOE.

In addition to the new capabilities provided by the South Hall Ring, Bates has recently constructed several major new detectors. The Focal Plane Polarimeter is now being used very successfully for experiments which require measurement of outgoing proton polarization. The Out-of-Plane Spectrometer allows unique measurements of kinematic correlations of outgoing reaction products. These new experimental capabilities, coupled with ongoing improvements in accelerator operation, provide an unprecedented opportunity to address critical issues in medium-energy physics.

The SAMPLE experiment at Bates, designed to provide crucial information on the quark structure of the proton, has produced its first published result. This experiment places very demanding requirements on the Bates beam quality, polarization, and stability, but is an opportunity for a world-class physics contribution.

LNS nuclear physics researchers are also leading several important efforts at accelerator facilities other than Bates. These facilities include TJNAF (Virginia), LANSCE (New Mexico), DESY (Germany), and Mainz (Germany). The project at DESY is an experiment to study the spin structure of neutrons and protons, using among other targets a polarized ^3He target constructed at MIT. The first two years of data-taking have been notably successful and first results have been published. LNS researchers have also led the design and construction of detectors for experiments at other facilities, such as TJNAF.

LNS also has a major role in the field of heavy-ion physics. In recent years the emphasis has been on studies of relativistic interactions of heavy-ion projectiles, especially as they may shed light on the question of the existence and properties of the so-called "quark-gluon plasma". This new state of matter is predicted to exist at temperatures and densities higher than those present in normal nuclear matter, but which may be present for a brief time in collisions of heavy ions. LNS researchers are leading the current experimental efforts using heavy-ion beams at Brookhaven. The LNS group is also the leader of one (PHOBOS) of the few experiments approved for the Relativistic Heavy Ion Collider (RHIC) under construction at Brookhaven. This experimental project is now well underway and aiming for RHIC startup in 1999. A complementary effort of the heavy-ion group is a search at CERN for the possible creation of a new excited state of the vacuum known as a disoriented chiral condensate.

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 and the theory that governs them. In addition, it uses our present knowledge of this theory to advance our understanding of a variety of subjects, including the structure and interactions of hadrons and nuclei, new forms of matter which may be created experimentally or observed astrophysically, and the behavior of the early 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. An important contribution at MIT has been the development of a general field theory of closed strings. It has been shown that this theory is independent of the background field that is used in its construction. Recently an MIT theorist (with collaborators) showed that string theory leads to a successful microscopic description of low-energy Hawking radiation, reproducing the semiclassical results both for the emission rate and for the angular momentum distribution.

Since string theory reduces to traditional quantum field theory at low energies, it can be used to analyze the properties of field theory. An MIT researcher (in collaboration) has uncovered strong evidence that some of the exciting dualities (i.e., exact equivalences between seemingly disparate theories) recently found in quantum field theories can be understood as low-energy consequences of string theory symmetries.

MIT theorists have also been pursuing the use of the early universe as a complement to accelerator experiments in testing particle theory ideas. Recently they have developed, and are pursuing, a new version of inflationary cosmology based on the underlying particle of supersymmetry breaking.

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, QCD. Recent lattice solutions have provided strong evidence that the structures of nucleons, pions, and other light hadrons are dominated by topological excitations of the gluon field. The recent donation of a 24-Gigaflops cluster of symmetric multiprocessors will greatly enhance lattice calculations in LNS.

MIT has played a pioneering role in exploiting high energy scattering to determine the quark and gluon structure of nucleons and nuclei. Significant new developments have been the determination of the behavior of structure functions in the new regime to be studied at TJNAF, the discovery of new ways to measure spin-dependent structure functions, and the first successful theory of the fragmentation function for pions. Electroweak interactions are a continuing focus of research. The unique opportunities provided by the new South Hall Ring at the Bates accelerator have motivated studies of reaction mechanisms, of new ways to use nuclei to test fundamental symmetries, and of spin and polarization observables.

EDUCATION

Since its founding LNS has placed education at the forefront of its goals. At present approximately 75 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.

Robert P. Redwine

CENTER FOR CANCER RESEARCH

The Center for Cancer Research was established in 1973 to study fundamental biological processes related to cancer. The goals of the Center's research can be generally stated as developing an understanding of (1) the genetic and molecular basis of cancer, (2) how alterations in cellular processes affect cell growth and behavior, and (3) 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 258 people work in the Center, distributed among the research laboratories of 13 faculty. In addition, three faculty members in the Whitehead Institute, one in Biology, and one in Chemistry 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, 2000. In addition to the core grant, the Center's faculty have a total of 46 fully funded projects (plus over half a million dollars of competitive support in fellowships for postgraduate studies). This support comes largely from the National Institutes of Health and the Howard Hughes Medical Institute and from a variety of foundations supporting research in particular disease areas (American Cancer Society, Hereditary Disease Foundation, Muscular Dystrophy Association, National Neurofibromatosis Foundation, 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 FY97 research volume was approximately \$13 million, which does not include \$3.7 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. 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.

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. 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 research advances in the past year include:

- The development by the Hopkins lab of efficient procedures for insertional mutagenesis in the model organism, zebrafish. These procedures allow identification of novel genes controlling development, cancer and other processes.
- The discovery and isolation by the Housman laboratory of genes causing acute myeloid leukemia. Two such genes were identified by sophisticated genomic analyses. Both represent fusions of other genes and their structures provide fascinating insights into the mechanisms for initiation of leukemia.

-
- The generation by the Hynes laboratory of strains of mice lacking vital cell adhesion molecules leading to failures in protection against bacterial infections; these mice provide models for human immunodeficiency diseases. Other mutant mice developed in the laboratory are models for human bleeding disorders.
 - The discovery by the Lees laboratory of a novel level of regulation of gene transcription factors important in control of the cell cycle, which is altered in cancer cells.
 - The discovery by the Liu lab of a target for a very promising anticancer drug inhibiting tumor angiogenesis, the development by tumors of blood vessels necessary for their survival.
 - The discovery by the Ploegh laboratory of novel mechanisms by which viruses subvert the immune systems to evade immunological rejection and allow viral latency.
 - The development by the Tonegawa lab of methods for ablating specific genes at defined locations in the brain in order to study the processes of learning and memory.

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. Our colleague, Dr. Phillip Sharp, has served as Head of the Department for the past six years. Dr. Frank Solomon serves as Chairman of the Department's Graduate Program. 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 71 graduate and undergraduate students and 80 postdoctoral fellows/associates. The Center also benefited from a number of international faculty-rank visitors during the past year.

It is a pleasure to report the following honors and awards to faculty of the Center during this past year:

Jianzhu Chen will be named to the Latham Family Career Development Chair July 1, 1997.

David Housman was named Novartis Professor of Biology.

Richard Hynes was a co-recipient of the 1997 Gairdner Foundation International Award.

Tyler Jacks received the 1997 American Association of Cancer Research Rhoads Award, and was named the first Daniel K. Ludwig Scholar at MIT. Also, Professor Jacks will be promoted to Associate Professor with Tenure July 1, 1997.

Frank Solomon was elected Chair of the Education Committee of the American Society of Cell Biology.

Richard O. Hynes

CENTER FOR SPACE RESEARCH

CSR conducts an active program of research in astronomy, astrophysics, space science, and related technology, with emphasis on investigations in support of 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 facilities. Research carried out in CSR is reported by the following departments: Physics, Earth Atmospheric & Planetary Sciences, and Aeronautics & Astronautics.

HIGHLIGHTS OF THE YEAR

The orbiting Bruno B. Rossi X-ray Timing Explorer (RXTE), named in honor of late MIT Prof. Rossi, has successfully completed 18 months of observations of compact objects in our galaxy (neutron stars and black holes) as well as active galactic nuclei through the variability of the intensities of the X-rays emitted by these objects. The All Sky Monitor (ASM), one of two instruments prepared at CSR, monitors the intensities of about 70 cosmic X-ray sources; the results have revealed orbital periods, super-orbital periods, state changes, and bursts (Prof. Bradt, Drs. Levine, R. Remillard, W. Cui). Intensity oscillations in the range 300 - 1000 Hz have been discovered in more than a dozen neutron-star sources (Prof. W. Lewin, Dr. Morgan, Prof. Bradt). Extensive studies of the black-hole systems called "microquasars" reveal quasi-periodic oscillations and explore the relation between accretion and relativistic jet formation (Drs. Morgan and Remillard). These systems as well as other black-hole systems (Dr. Cui) provide information pertaining to the angular momenta of the black holes. A puzzling neutron-star source (Cir X-1) is being studied extensively (Prof. Bradt, Dr. Levine, Dr. Morgan). Dr. V. Kaspi has established a new program to observe rotation-powered pulsars primarily at radio wavelengths but also in the X-ray and gamma-ray regions. She recently discovered a new, young, energetic pulsar and is following up with several satellite and ground-based observations. Prof. W. Lewin continues his study of quasi-periodic oscillations of low-mass X-ray binaries, having now discovered more than half of the 13 known systems in the Milky Way, and also having helped increase by 35% the known sample of gamma ray burst sources from the Compton Gamma-Ray Observatory. CSR continues participating in ASCA, a Japanese/US X-ray astronomy satellite which was launched in 1993 and carries CSR's CCD X-ray detectors (developed in collaboration with Lincoln Laboratory).

The Magellan Project consortium includes MIT, the Carnegie Institution of Washington, Harvard University, and the Universities of Arizona and Michigan. Two 6.5 meter diameter optical telescopes are being constructed on Cerro Las Campanas in Northern Chile, the first scheduled for completion in early 1999. Construction of enclosure and fabrication of the telescope structure are nearly complete, and polishing of the mirror is underway (Profs. C. Canizares, J. Elliot & P. Schechter). Using the Michigan-Dartmouth-MIT Observatory, time delays have been measured for the multiple images of a gravitationally lensed quasar, giving a new estimate of the Hubble parameter (Profs. J. Hewitt & P. Schechter).

The interplanetary plasma group monitors solar wind conditions from three spacecraft, two near Earth (IMP 8 and WIND) and one at 52 Astronomical Units (Voyager 2). A clear signature of the recent solar minimum was observed at Voyager 2, a surprise given the large distance. IMP 8 and WIND are being used to trace the progress of eruptions on the Sun as they move toward Earth, in hopes that space weather events, which can affect satellites, terrestrial communications and electric power grids, can be better forecast in the future. (Prof. J. Belcher, Drs. A. Lazarus, J. Richardson, J. Steinberg, Ms. K. Paularena).

Analysis of the anomalous microwave scattering properties of the Venus highlands are directed at finding an explanation for the variations in altitude of the low-emissivity behavior observed there. If this is related to the condensation temperature of tellurium, as we believe, these variations reflect variations in surface temperature at a given altitude (Prof. G. Pettengill & Dr. P. Ford).

The joint Caltech/MIT LIGO (Laser Interferometer Gravitational-wave Observatory) Project, for the detection and study of gravitational radiation from celestial sources, is now 40% complete. At the Hanford, Washington site the building foundations and structures were built, and beam tube fabrication and installation is underway. At the Livingston, Louisiana site, the grading is complete and has settled, permitting construction to commence. The detector design is nearing completion; sample mirrors of 20 cm diameter and 1 nm figure have been polished and the

coating technology developed to maintain this figure. The Phase Noise Interferometer at MIT has achieved "world's best" measurement of phase noise, splitting an optical fringe to one part in a billion. (Prof R. Weiss & Dr. D. Shoemaker)

Theoretical investigations include: supercomputer simulations of large scale structure in the universe (Prof. E. Bertschinger) and of the hydrodynamics of binary star coalescence (Prof. F. Rasio); work on the origins and dynamical evolution of extrasolar planetary systems (Prof. F. Rasio); studies of the evolutionary histories of collapsed stars (white dwarfs, neutron stars, and black holes) in binary systems, including binary millisecond pulsars (Profs. S. Rappaport & P. Joss); investigations of the ages of the oldest stars in globular clusters and the implications for the age of the universe, supernovae in binary star systems and detectability of brown dwarf stars in the Galaxy (Prof. Joss). Closer to Earth, a new innovative theory of multiscale intermittent turbulence has been developed for the description of the Earth's magnetotail. (Dr. T. Chang).

In the area of aerospace technology, an Advanced Dynamic Load Sensors Experiment has been conducted on the MIR space station to assess the impact of human space activity on the space station (Prof. D. Newman), and a program of flight simulator research on terrain situation awareness cockpit displays has been initiated (Dr. C. Oman). Prof. C. Counselman has developed a new kind of antenna for satellite geodesy, which promises to improve substantially the accuracy and speed of geodesy and navigation using the Global Positioning System.

UPCOMING PROGRAMS

The High Energy Transient Experiment (HETE), to search for gamma ray burst sources, was successfully delivered to NASA by CSR, but the satellite was lost following failure of the launch vehicle. NASA has now approved rebuilding the satellite for launch in 1999 (Dr. G. Ricker). New cameras are also now being built for the next Japanese/U.S. X-ray mission, Astro-E, to be launched in 1999 (Drs. G. Ricker & M. Bautz).

AXAF is a major NASA mission of the "great observatory" series, scheduled for launch in 1998. Two of the four major instruments, the High-Energy Transmission Grating Spectrometer (Prof. C. Canizares) and the AXAF Charge-Coupled Device (CCD) Imaging Spectrometer (Drs. Ricker & M. Bautz), have now been successfully completed and delivered to NASA. Extensive calibration of the state-of-the-art instruments is underway. The first set of AXAF observations are being planned. CSR is also active in the AXAF Science Center, which will oversee the operation of AXAF during the mission (Prof. Canizares).

An experiment for the 1998 "Neurolab" mission is in active development and an extension of the experiment was approved for flight on the International Space Station. Ground based research continues on human spatial orientation in real and virtual environments, EVA biomechanics, and a new research initiative on artificial gravity physiology and human factors (Profs. L. Young & D. Newman, Dr. C. Oman).

Prof. Pettengill and Dr. Peter Ford are involved in the Mars Orbiter Laser Altimeter Experiment, onboard the Mars Global Surveyor spacecraft due to be placed in orbit around the red planet in September 1997. This experiment will yield a precision global topographic map of Mars.

More information about this center can be found on the World Wide Web at the following URL:
<http://space.mit.edu>.

Claude R. Canizares

CHAIR OF THE FACULTY

FACULTY POLICY COMMITTEE

This year 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 FPC met twice with President Vest, once with Provost Moses and once with incoming Chairman of the Corporation, Mr. d'Arbeloff. It also convened a meeting with the Deans of the five Schools. The Committee used these opportunities to convey faculty opinions on a variety of topics ranging from classroom renovations to reengineering and adjunct teaching appointments.

The FPC also heard from and coordinated the work of several other committees and reviewed several changes in academic policy, procedures, and programs, some of which were forwarded to the Faculty for approval.

UNDERGRADUATE COMMUNICATION REQUIREMENT

Throughout the fall, the Committee on the Writing Requirement (CWR) and the Committee on the Undergraduate Program (CUP) worked in tandem to address MIT students' need for more comprehensive instruction in written and spoken communication skills. In the spring, Professor Kip V. Hodges, Chair of the CWR; Professor Charles Stewart III, Chair of the CUP; and Associate Dean Leslie Perelman of the Undergraduate Education Office presented the FPC with a motion for the Faculty to consider replacing the current Institute Writing Requirement with an Institute Communication Requirement. After considerable discussion, the FPC voted in unanimous support of forwarding the motion to the Faculty. The proposal was brought before the Faculty at the March meeting and approved in April.

MASTER OF ENGINEERING PROGRAM IN LOGISTICS

In March, the FPC met with Professor Yossi Sheffi, Director of the Center for Transportation Studies (CTS) to discuss the proposed Master of Engineering Program in Logistics. The CTS is an interdepartmental unit which currently offers a Master of Science in Transportation (MST) and a Ph.D. in Transportation. The MEL degree is a one-year program designed to provide students with the analytical tools to tackle logistics issues and contribute to manufacturing and retail organizations on the one hand, and the rapidly expanding logistics services and consulting industry on the other.

The program should attract people with three to ten years experience in the transportation industry and those with MBAs who want to enter the logistics field. The narrow focus on logistics calls for a highly structured program, so the 90-unit curriculum has only one elective. The program will be governed by the CTS Education Committee, which also oversees the MST and Ph.D. programs. The Center will include funding for the MEL program in its business plans for the next few years until the MEL program can pay for itself. CTS also intends to offer strong placement services to MEL graduates through its corporate and public affiliate programs.

The most significant feature of the MEL proposal was that it would become the first interdepartmental Master of Engineering degree. However, the CST has already addressed concerns about governance, admissions, and registration through its handling of MST students. Furthermore, prior to the FPC's discussion, Professor Bacow solicited and received letters of support from the appropriate department heads to assure their willing participation in the MEL program. Therefore, all felt that CTS could resolve any funding and procedural issues using the current administrative structure. FPC discussion of the MEL program also raised the larger issues of faculty and financial resources channeled into one-year programs. Nonetheless, the Committee endorsed the proposal which was put to the Faculty at the March meeting and approved in April.

As a result of objections raised at the April meeting, the FPC took steps to clarify the principles governing the naming of M.Eng. degree titles. In the past, both Ocean Engineering and Nuclear Engineering had sought and been denied approval for M.Eng. degrees with titles other than that of the department. In the case of Ocean Engineering, the Committee on Graduate School Policy ruled that M.Eng. degree titles were limited to departmental names and the FPC had recommended degrees with departmental names and different tracks. At that time, the FPC was concerned about title proliferation and jurisdiction. However, with the M.Eng. in Logistics, the FPC had required letters of support from the relevant department heads, and the Committee felt that the Institute had learned how to

handle such degrees. As a matter of practice, the FPC agreed on the following principles in the naming of M.Eng. degrees:

- M.Eng. degrees will use the department name unless a reasonable argument can be made otherwise.
- Title proliferation should be discouraged.
- Departments seeking degree titles that differ from the department name should seek the concurrence of other interested departments.

QUALITY OF FACULTY LIFE

Early in the fall, the Committee identified quality of faculty life as one of its priorities. In response to its concerns, the FPC formed a subcommittee chaired by Professor Bailyn and including Professors Keyser, Potter, and Royden. At the same time, discussion continued at the committee-level with an October visit from Ms. Lydia S. Snover, Senior Planning Officer for Institutional Research. Ms. Snover described the results of the Higher Education Research Institute Survey of Faculty. Approximately one-third of the MIT Faculty had responded to the survey, with over-representation of women and non-tenured faculty. In reviewing the results, FPC members observed clear indications of stress among faculty and noted that women faculty seem to experience stress differently from men, both before and after tenure. In addition, the data seems to indicate widespread support for periodical reviews of tenured faculty and to reflect that women have lower job satisfaction than men, as seen in the higher numbers of women reporting sexual harassment and the fact that women consider leaving academia at two times the rate of men. FPC members agreed that there were a number of questions and issues worthy of further study.

In April, the FPC subcommittee reported its findings to the Committee. It had begun by defining the topic as issues of work and personal life for MIT faculty and by asking whether MIT faculty could be successful and still have meaningful involvements outside the Institute, i.e. with family or community. The subcommittee looked at the apparent increase in faculty stress levels and at the implications this trend could have on the Institute's work climate, the quality of research and teaching, and its personnel policies. It was concerned that the Faculty and administration might have difficulty acknowledging that the levels of stress MIT faculty experience are problematic. The group was unable to offer definitive solutions, but felt it imperative to continue investigation and discussion. As part of its continuing inquiry, the subcommittee agreed to give attention to the medical costs of stress.

After hearing the subcommittee's findings, the FPC engaged in a vigorous discussion which centered around the stresses of the tenure process and the difficulty of balancing personal responsibilities with research, teaching, and administrative commitments. A number of suggestions were made with the goal of reducing stress, particularly for junior faculty. These included: more flexibility in the tenure clock, subsidized housing for junior faculty, a faculty allowance for domestic assistance, and increased availability of day and elder care. FPC members agreed that solving these problems would make MIT more attractive to prospective faculty and would positively affect graduate students as well. At the same time, they urged that possible solutions be measured in terms of cost effectiveness.

By and large, the Committee found these to be important issues and felt that discussion should be continued and brought to the Institute-level. The majority of members agreed that while more investigation clearly needs to be done, MIT can and should begin to address some of the more obvious symptoms immediately.

TENURE

The FPC discussed tenure in a variety of contexts throughout the year. In December, it met with Professor Nicholas P. Negroponte, Director of the Media Lab to talk about tenure as it pertains to media research. Within that context, Professor Negroponte felt that faculty on the tenure track are unlikely to pursue peripheral or radical research because they are pressured to conform to tradition in order to get tenure. While he was aware of non-tenured MIT faculty members who have had successful careers at MIT, he pointed out that without the title of professor, faculty and researchers are often considered second class citizens at the Institute.

Later that month in a meeting with the Deans, discussion focused on possible suggestions for changing tenure including: eliminating tenure, awarding tenure for a fixed term (25 or 30 years), requiring periodic peer reviews, and lengthening the tenure probationary period. The Deans' concerns centered on the need for intellectual renewal among the Faculty heightened by the combination of tenure and the end of mandatory retirement; sensitivity to young faculty members' needs in terms of career development, family and work issues, and opportunities to get

expertise from industry; and the need to find more meaningful and continuous post-tenure review to stimulate a dynamic and encouraging intellectual climate.

In the spring, discussion of tenure turned to the timing of the tenure clock, the differing pressures this clock places on men and women faculty, and the impact the clock may have on choice of research topics. In the end, the FPC agreed that the issues surrounding tenure are multifaceted and complex, that they need to be further examined and discussed, and that it is the role of the Faculty to recommend modification to the current system if necessary.

WOMEN IN THE SCHOOL OF SCIENCE

In March, the FPC met with Dean Robert J. Birgeneau of the School of Science and Professors Mary C. Potter and Paola M. Rizzoli to discuss the Report of the Committee on Women in the School of Science. Professors Potter and Rizzoli chaired the committee, and FPC members Royden and Hopkins each served on the committee for part or all of its deliberations.

The committee found that many women faculty in the School of Science feel marginalized, particularly after they have achieved tenure. The FPC was particularly interested in the impact of the committee's report on the School of Science and in what lessons might be more broadly applicable to other areas of MIT. Dean Birgeneau commented that the committee's work has been helpful on every level—from demonstrating better ways to collect data, to its advice about considering outside offers in determining faculty salaries. The committee taught the School how to look at the challenge of increasing women faculty and gave the School the tools to address it. As a result, the School has made significant strides in hiring women faculty for the coming year. Interacting with individual departments on these issues has been a constructive process as well, and Dean Birgeneau concluded that the procedures developed in conjunction with the committee would be useful to other MIT Schools. He added that he does not believe that the problems identified in the report are unique to the School of Science, and he thinks that the recommendations are valuable because of what it took to make them. He does not believe that he would have come to the same point of total agreement and compliance if he had not been part of the whole process.

After hearing the report, FPC members expressed hope that women faculty in all areas of MIT would view the committee's work as a sign of encouragement to evaluate their own situations. The FPC encouraged Dean Birgeneau and the committee to work with the academic deans and women faculty in the other Schools to initiate the same process of evaluation and to help them draw their own conclusions.

DIVERSITY

In April, Professor Harris, Co-chair of the Committee on Campus Race Relations visited the FPC to discuss issues of diversity at MIT. Professor Harris feels we continue to face issues relating to diversity and civility across the Institute. She called for discussion and opinions on what the Faculty could and should be doing to address the problems. In speaking to various groups, Professor Harris has encountered considerable denial on the part of faculty members. She noted that faculty often identify racism as a student problem or blame MIT's housing system.

Professor Harris screened excerpts from the *It's Intuitively Obvious* videotapes which document students from different racial groups discussing experiences and attitudes towards race while at MIT. The FPC found the tapes powerful and compelling. In the subsequent discussion, Sloan's Professional Conduct Day was strongly praised by FPC members who had participated. The Committee also endorsed increased effort towards recruiting and retaining qualified minority candidates for faculty positions. Noting that faculty often fail to adequately direct the behavior of TAs, particularly in regard to social issues, one member suggested that all TAs be videotaped to record their teaching technique and how they interact with students.

The FPC encouraged Professor Harris and the CCRP to pursue the development of a diversity training program for teaching and administrative staff. Since student impressions and attitudes are largely formed during the first two years at MIT, it was recommended that the training begin by targeting faculty and TAs from ten to twenty of the largest early courses.

ROTC TASK FORCE UPDATE

The ROTC Implementation Team was formed as the result of a Faculty vote in April 1996. Team members are Professor Phillip L. Clay, Dean Margaret R. Bates, Ms. Sarah E. Gallop, Professors J. Kim Vandiver and William B.

Watson. In Spring 1997, all members of the Team except for Professor Watson, attended an FPC meeting to update the Committee.

The Implementation Team stated the following as its primary goals:

- Develop mechanisms to mitigate financial and other difficulties that students might face with regard to ROTC participation if they should declare themselves to be homosexual.
- Broaden the access to MIT's ROTC program through curriculum enhancement.
- Improve the climate for homosexual faculty and students at MIT, within the constraints of existing law.
- Continue to monitor national actions and potential opportunities to affect change.

At the time of the meeting, the Team had implemented the following:

- A reinsurance program to help students deal with the financial consequences of disenrollment from ROTC due to sexual orientation;
- Development of a modified ROTC curriculum; and
- National advocacy and local dialogue: the Team has consulted with other colleges, universities, and advocacy groups to explore opportunities for joint action and legal advocacy, and has worked to improve the climate on campus including the establishment of a group in the Dean's office to provide support to the gay student population.

FPC members discussed the need for built-in incentives for non-ROTC students to participate in a leadership program. They also agreed that the intention of the Faculty vote was to keep the discussion alive and to identify opportunities where MIT can play a leadership role. The FPC felt that MIT should continue to work towards a campus atmosphere which is accepting of diversity of all kinds and offered support to the Implementation Team as it continues to pursue its goals and objectives.

The Implementation Team made its report to the Faculty at the May meeting. At that time, concern was expressed that MIT was backing away from its commitment to the elimination of discrimination in the military. The Team reiterated its pledge to broaden access to ROTC and improve the campus climate for homosexual students and faculty. There was also concern that the reinsurance policy might be inadequate and in response, the Committee on Undergraduate Admissions and Financial Aid agreed to examine other options more closely during the coming year.

CLASSROOM RENOVATIONS

During the fall, the FPC made classroom improvements a priority and asked Dean Rosalind H. Williams to consult with the appropriate staff from Physical Plant, Audio-Visual Services, the Planning Office, and the Registrar's Office. Last fall, she presented her findings to the CUP and the Committee for the Review of Space Planning and in January, she met with the FPC to outline progress on classroom renovations. By that time, tentative plans had been made to renovate 33 classrooms over one, two, or three years, with the timetable contingent somewhat upon raising funds to complete the project.

FPC members expressed astonishment at the dilapidated state of many Institute classrooms and at how little money there is available to maintain—much less renovate—teaching facilities. Dean Williams also raised the issue of updating classrooms to take advantage of changing technology, which would add additional expenses to renovations. She agreed to approach Vice President for Resource Development Barbara Stowe about soliciting contributions to fund the capital improvements, but emphasized that these efforts will require input from the Provost and faculty.

ACADEMIC COMPUTING

In November, Dr. Kumar, Director of Academic Computing visited the FPC. At the time of his visit, he was speaking with faculty and students across the Institute to determine their needs on Athena and other academic computing equipment, and to gather their input on third party software. He noted that the relationship between academic computing and the Faculty is extremely important.

During the meeting, FPC members expressed their wishes vis à vis academic computing:

-
- More help with custom tailoring MIT software and assistance with choosing off-the-shelf software.
 - A computer environment which would bring the students and faculty into better communication, creating a more collaborative working environment where academic computers are part of the teaching and learning environment, providing common visibility and interaction for curriculum, assignments, and comments.
 - Updates on what software is available and as well as support personnel to assist with work on the Web.
 - Getting students and faculty onto a mainstream common denominator, i.e. if Pentium PCs are typically mainstream, workstations could be eliminated.
 - Helping faculty to catch up with the students on the uses of Athena and the Web.
 - Increased Athena access through more work stations and less congestion for remote dial-ups.
 - Providing an 800 number for tel-net dial-ups. Although there are negative ramifications associated with making MIT universally and freely accessible, closer ties with industry, more off-campus collaborations, and other changes in faculty-industry relations take faculty off campus more often than in past decades.

“PROFESSOR/ASSOCIATE PROFESSOR OF THE PRACTICE OF...”

In a December meeting with the FPC, Dean William H. Mitchell articulated the need for a alternative kind of adjunct appointment. The Department of Architecture has historically appointed half-time Adjunct Professors (most of whom are distinguished in their industry careers), Senior Lecturers, and Senior Research Scientists (who engage in teaching) in order to attract design practitioners whose professional career schedules do not mix well with typical tenure schedules. Yet, the Department continues to struggle for ways to engage young junior designers for whom the demands of developing an external practice while under the tenure clock are nearly impossible and to attract individuals to teach specific subjects, such as the law of architecture.

In March, Dean Mitchell returned to the FPC with a proposal to establish two levels of faculty: “Professor of the Practice of...” and “Associate Professor of the Practice of...” This proposal was the result of considerable discussion and consultation with a variety of constituencies. After reviewing the proposal, the FPC raised a number of pointed questions but agreed to support the proposal contingent on some further clarifications. It also recommended that the standard five-year review of the program be incorporated. The proposal was presented to the Faculty at the May meeting and will be included in the revised edition of *Policies and Procedures*.

TASK FORCE ON STUDENT LIFE AND LEARNING UPDATE

In January, the Task Force on Student Life and Learning updated the Committee on its activities. During discussion, several FPC members agreed that the typical faculty job description does not foster interaction with undergraduates, particularly on the level of students’ day-to-day lives. At the same time, some members felt that advising and mentoring are ideal ways for faculty to engage undergraduates on a more personal level. The FPC cautioned the Task Force against writing a broad and bland mission statement, which would provide no catalyst for change, and urged it not to shy away from identifying things that are important or from recommending real action to implement their findings.

COMMITTEE ON THE USE OF HUMANS AS EXPERIMENTAL SUBJECTS

Questions by the Faculty regarding how the Committee on the Use of Humans as Experimental Subjects (COUHES) makes decisions and recommendations, led to the committee’s meeting with the FPC. After explaining its charge and approach, COUHES Chair Dr. H. Walter Jones acknowledged that approval of some non-invasive, non-research processes might be handled administratively. The FPC agreed to form a subcommittee to work with COUHES to clarify activities which might be presumptively exempt from review.

RETIREMENT

With several problems facing MIT in regard to faculty retirement, the FPC asked the Committee on Faculty-Administration (CFA) to reevaluate the pension plan and if necessary, to make recommendations regarding modifications. As is common at research universities where teaching loads are lighter, MIT has a relatively high number of faculty who continue to work past age 70. In addition, now that retirement is no longer mandatory, there are increasingly more faculty who view their pension as an estate-building vehicle: every year one continues after the Normal Retirement Date (NRD) means considerable increase in pension build-up.

The CFA felt that MIT needs to develop incentives to increase retirement on or before the NRD and offered these options for consideration: consider re-negotiating the NRD; place a cap on the defined benefit pension plan so that participation would be shut off after a specific number of years, thus eliminating the incentive to continue working and accumulating past the NRD; offer a more enticing medical plan upon retirement; and build in inflation protection by indexing the pension plan.

FPC members responded with a number of comments and suggestions. Some felt that MIT must take a more holistic approach to faculty retirement and consider the professional and personal implications as well as the financial ones. They thought that the Institute should create a culture in which faculty consider part-time and emeritus status, and should encourage long-range retirement planning. Members stressed that retirement policies should be institutionalized, because the present situation in which each individual negotiates a personal deal is inequitable and breeds ill will. They viewed retirement as part of the larger and fundamental issue of faculty relationships with MIT both during and after employment. They urged MIT to clarify its objectives in terms of the faculty pension plan and retirement policies in order to resolve any of the potential problems. Issues surrounding faculty retirement affect the environment of the MIT community, members agreed that the intellectual renewal of the Faculty through retirement is good for the Institute.

CLASSROOM RENOVATIONS

During the past year, the Committee on the Undergraduate Program (CUP) played a key role in moving forward a proposal to renovate a substantial number of MIT classrooms over the next several years.

UNDERGRADUATE COMMUNICATION REQUIREMENT

The CUP endorsed the report of the Committee on the Writing Requirement and forwarded a recommendation to the Faculty that it authorize a two-year series of pilot programs and experiments to help in the design of a new Communication Requirement. The committee will report back to the Faculty with its recommendation for a new requirement not later than the Spring of 2000. In the meantime, a subcommittee of the CUP will be formed to oversee the two-year experiment.

COMMITTEE ON THE FIRST YEAR PROGRAM

This year, the new Committee on the First Year Program was established as a permanent subcommittee of the CUP. This group, chaired by Professor Thomas J. Greytak during 1996-97, was charged with assisting the CUP in carrying out its freshman year oversight and review responsibilities, working with departments and the Dean for Undergraduate Education to effect small scale and short term improvements to the first year program, and considering larger scale changes that should be taken up by the CUP.

SUBCOMMITTEE ON FRESHMAN ADVISING

The CUP charged and received the recommendations of its Subcommittee on Freshman Advising. The subcommittee, chaired by Professor Linn W. Hobbs, deliberated throughout the year and submitted its report in May. Discussion of its recommendations will continue in the fall.

POLICIES AND PROCEDURES

During 1996-97, the CUP looked at policy issues governing subject prerequisites, the giving of evening quizzes by daytime classes, and the 5-7 P.M. period were the subject of two meetings in the spring. Since improvement or clarification of these policies should assist their practice, discussions will continue next year.

In addition, the Chair of the CUP was involved in the development of a new financial hold policy that is currently being reviewed by the Committee on Academic Performance (CAP).

EXPERIMENT UPDATES

The CUP heard updates from two groups involved in experiments licensed by CUP. The Subcommittee on Intermediate Grading, chaired by Professor Paul A. Lagace made a progress report to the CUP and will make final recommendations in Spring 1998. In addition, the CUP heard about the progress of the three-year HASS-D Experiment incorporating visual and performing arts into the requirement from Dr. Bette K. Davis, Dean Philip S. Khoury, and Professor James Paradis. The goals and timing of this experiment—scheduled to end in 1998-99 and to culminate in a review of the entire HASS requirement—will be discussed again by CUP in the upcoming year.

PROGRAMS AND INITIATIVES

The CUP monitored the progress of a number of on-going programs and initiatives:

- It heard the initial recommendations of the Student Services Reengineering Co-Curricular Implementation Team that included the development of an integrated scheduling and events management office. Concern was expressed by members that classroom oversight and scheduling not be folded into an otherwise student activity-focused operation.
- It heard twice from a group of staff and students who were developing a new MIT-administered subject evaluation process.
- It provided advice and faculty perspective to the plans for hiring a new Registrar, a new Director of Admissions, and a new Director of Career Services in the Dean's Office.
- On a number of occasions CUP was asked to provide input to the newly-constituted Task Force on Student Life and Learning. An update and discussion of Residence/Orientation Week included participation by Task Force members and resulted in planning for a survey of incoming students about their plans and expectations. An "issues list" was presented to the Task Force as well, containing over twenty items regarded by CUP members as chronic educational program dilemmas requiring attention at the strategic level.
- CUP heard from the co-chairs of the Educational Studies Working Group, who presented the results of their 1995 survey of sophomores about their first year experience.
- The CUP heard about upcoming changes in the engineering accreditation ABET guidelines that will follow as a result of the "ABET 2000" reforms.

OTHER FACULTY COMMITTEE REPORTS

The **Committee on Academic Performance** acted on a total of 645 petitions during the last academic year, an increase of twelve percent over the previous year. (Approximately half of these petitions were acted upon administratively by the Chair and the remaining were brought to the committee). The Committee saw a forty percent increase in petitions for late drops, as well as a steady increase in the number of financial hold petitions over the last five years. CAP actions voted at the end-of-term grades meetings resulted in a total of 51 Required Withdrawals (the same number as last year) and 446 Warnings (compared with 433 last year).

In addition to considering petitions, the CAP dealt with the implementation of the new Incomplete policy which went into effect in Fall 1996. The Committee also dealt with issues regarding the IAP Credit Limit and Financial Holds.

In Fall 1996, the *Rules and Regulations of the Faculty* were amended to provide that grades of Incomplete must normally be completed by the add date of the semester following that in which they are assigned; that if they are not completed when agreed, the instructor must assign a grade based on work done; and that no student can graduate with an unresolved I on his/her record.

In the spring, two weeks before term-end CAP meetings, there were approximately two dozen seniors with unresolved I's on their records who were on the degree list to graduate in June. Through intensive work by all concerned, there were no unresolved I's among those students intending to graduate. This spring 185 I's were given, the lowest in five years. It contrasted with 265 in Fall 1996, and 256 in the Spring 1996. Thus the new system's goals seem largely to have been achieved in its initial year. However, the first year's experience suggests the need for continued broad dissemination of the new policy.

CAP received a number of petitions to exceed the twelve unit limit for IAP credit. Analysis of the issue suggests that two popular subjects begin in the fall semester and carry over into IAP and in two other subjects, credits are allocated both to the spring and fall. Students are apparently often unaware that they are already taking six units, and quickly exceed the twelve unit limit. The CAP concluded that a much wider communication effort aimed at students, departmental advisors, and administrative officers would help resolve the issue.

Some students who are prevented by Student Financial Aid Office policy from registering because their financial aid loans are in arrears, continue to attend classes. When their loans are brought into paid-up status, they petition the CAP for permission for retroactive registration. A year ago, the CAP determined to address this problem and to

examine variances in the elapsed periods of these requests. In November, the CAP along with CUP and Committee on Undergraduate Admissions and Financial Aid (CUAFA) held a meeting on the subject attended by a variety of “stakeholders.” Following this meeting, the Director of Student Financial Aid drafted a statement of current and future policy providing a one-semester grace period for late payment, followed by a strictly enforced set of sanctions designed to encourage payment on time or within the grace period. The new policy should be in force in the fall. Such a restated policy on financial holds, when enforced in Fall 1997, should reduce the number of petitions for late registration due to financial holds.

The **Committee on Curricula (COC)** met nine times during the 1996–97 academic year. The Committee approved proposals for new, canceled, and revised subjects, and reviewed student petitions for substitutions for the General Institute Requirements, as well as approving substantive curricular changes and upholding policy.

The COC approved 6.115 as an Institute Laboratory subject and approved a number of revisions to undergraduate curricula including changes to Course 2A to make the program more structured and rigorous; changes to Course 4 to formally create four “discipline streams” in place of its planned electives; and changes to Courses 1-A and 1-C to bring them into line with the 15 1/2 subject limit in the departmental program.

In the process of considering a proposal by Course 9 for a minor in Systems Neuroscience, the COC upheld the position, supported as well by the CUP, that there should be one minor per major, and denied the proposal.

The **Committee on Corporate Relations (CRC)** met actively through the academic year to consider the mission and activities of the Office of Corporate Relations (including Corporate Development and the Industrial Liaison Program), particularly in light of the findings of the Council on Industrial Relationships. The report of this Council (February 1997) recommended that the CRC also undertake ongoing discussions on the MIT impact of potential changes in MIT’s relationships with corporations, including the formation of partnerships. Meetings were held with the Provost and Vice President of Resource Development to clarify the expanded role of the Office of Corporate Relations in generating corporate gifts and research revenues, as well as to discuss the mission of the CRC itself. Suggestions were made to the Office of Corporate Relations to better communicate with faculty about changes in the mission and structure of OCR.

The **Committee on Discipline (COD)** heard charges against five students this year. The charges, all for academic misconduct, included stealing an exam and providing answers to an individual scheduled to take it, altering exams and turning them in for re-grading, and copying problem sets. The sanctions ranged from the withholding of a degree for one year and suspensions from the Institute, to a letter of warning. The Committee also reviewed a number of petitions for removal of disciplinary notations from transcripts. In addition, the Committee expects to hear approximately four other charges against students over the summer.

As in the past, the COD, in conjunction with the Dean of Student Affairs and Undergraduate Education, will regularly report disciplinary actions at Faculty meetings. The committee hopes that this will continue to alert faculty members to the need for consistent reporting of incidents to the COD or to the Dean’s office, so that students may become more aware of the risks they run when engaging in academic dishonesty.

This year the **Harold E. Edgerton Award Selection Committee** reviewed 11 nominations, some of them outstanding, for the Edgerton Award. After considerable deliberation, the committee selected Julie Dorsey as the recipient of the Harold E. Edgerton Award. Professor Dorsey of the Department of Architecture, was commended for her work in developing computer-aided design methods for lighting design and simulating the weathering of materials. She was also cited for her strong commitment to both undergraduate and graduate teaching.

This year, the **Committee on Faculty-Administration (CFA)** began a broad analysis of questions relating to faculty renewal. Attention was mainly focused on revising the pension system to make it more neutral in relation to faculty retirement decisions. Recommendations to be further refined included ending MIT contributions to the 401K plan after 30 or 35 years of service and pension supplements for full indexing when retirement occurs in certain age/years-of-service windows. Non-pension proposals included the development of a long-term care plan, indexing of after-retirement Medicare supplements, transition plans that allow for half-time employment for a number of years before retirement, and better ways for faculty members to retain linkage to MIT after retirement.

This year's **James R. Killian, Jr., Faculty Achievement Award Selection Committee** met a number of times throughout the year, solicited nominations, and followed up to obtain further information about the nominees. At the May Faculty Meeting, they enthusiastically announced that the 26th Killian Faculty Achievement Award would be presented to the Germeshausen Professor of Chemical and Biomedical Engineering, Robert S. Langer. The selection committee cited Professor Langer's pioneering work in the fields of drug delivery, artificial organs and angiogenesis, as well as his commitment to mentoring his students as reasons for this recognition.

In its first meeting of the 1996-97 academic year, the **Committee on the Library System** heard and discussed a detailed presentation by the Director, Ann Wolpert, on the attributes, financial position, and future directions of the MIT Libraries, and on the strategic issues facing the Library System. Key strategic initiatives include an increase in networked information resources and in the support of information technology, and an increase in development activities so as to build the Libraries' endowment. The second and third meetings were largely devoted to a discussion of the FY98 budget for the Libraries. Related concerns such as space needs, access, and acquisitions were raised by the committee. The committee also heard a report on the meeting of the Corporation Visiting Committee, in which some members of the committee had participated.

At the April Faculty Meeting, the **Committee on Nominations** presented the names of faculty members to serve on the fourteen Standing Committees of the Faculty as well as the names of the faculty members to serve as Associate Chair of the Faculty and Secretary of the Faculty.

At the May Faculty meeting, the Faculty voted to approve the nominations for the Associate Chair and the Secretary of the Faculty, and also to approve the 36 faculty members to serve on the Standing Committees.

As usual, the **Committee on Outside Professional Activities (COPA)** dealt with situations in which there were questions about potential conflicts of interest involving faculty, students, or staff. In addition, at Professor Bacow's request, the COPA investigated issues related to whether MIT was receiving reasonable compensation for intellectual property developed here, whether MIT's rules and safeguards related to equity and commercialization were in line with those of peer institutions, and whether MIT had proper guidelines in place concerning conflicts of interest that may arise as faculty pursue closer collaborations with industry. In each case, the committee's conclusion was that the current system serves the needs of the Institute without imposing an unnecessary bureaucracy or set of policing requirements that might discourage interactions with industry or threaten the sense of collegiality and loyalty that allow the current system to function very well.

The **Committee on Student Affairs** met regularly throughout the year. A frequent item on its agenda was a continuing interest in and input to the Institute Dining Review. The Committee's other principal focus was to commence an examination of second order gender issues, that is, how well does MIT perform as a setting for women students and a preliminary report was prepared for Dean Williams on this issue. Other topics discussed by the Committee included the future design and qualities of Lobby 7 and the Infinite Corridor as MIT's "front door and main street," and the possible sources of advice to incoming undergraduates on the use of credit cards.

The principal issue addressed by the **Committee on Undergraduate Admissions and Financial Aid** during 1996-97 was the implementation of the reinsurance policy for students who lose ROTC scholarships because of their sexual orientation.

The following policy implementation language was approved by CUFA on February 13, 1997 and approved for release by the ROTC Implementation Team on February 21, 1997. This policy was included in a report to the MIT Faculty at the May 1997 meeting. It will also be included in appropriate abbreviated forms in future admissions and financial aid publications.

On April 17, 1996, the MIT Faculty approved the Task Force motion addressing ROTC programs on campus and the conflict between MIT's policy on non-discrimination and Department of Defense (DOD) policy which discriminates against homosexuals. The motion included the following item dealing specifically with financial support:

MIT will reinsure MIT students who lose ROTC scholarships due to their sexual orientation with a financial-aid package consisting of the standard need-based MIT scholarship, plus an optional supplement contingent upon public service.

The objective of this element of the motion was to:

... counteract, to the extent we can, the on-campus consequences of current discriminatory policies against homosexuals in the US military by reinsuring the DOD scholarships of disenrolled homosexuals.

In its final report, the ROTC Task Force proposed that responsibility for implementing and overseeing the reinsurance policy be given to CUAFA. The following policy statement implements that part of the motion dealing with reinsurance.

The CUAFA policy on MIT ROTC students whose scholarships are terminated (with editorial corrections made on April 4, 1997) is as follows:

- Any student who is disenrolled voluntarily or involuntarily from an MIT ROTC scholarship program is eligible to apply for the standard MIT financial aid packages and should do so to determine their level of eligibility.
- Any ROTC scholarship student whose ROTC scholarship is terminated because of sexual orientation may also request supplemental loans beyond the standard financial aid package. The maximum annual amounts of these supplemental loans would be the difference between the original annual ROTC award and the sum of the grants, loans, and self help making up the standard annual MIT financial aid award. Unless forgiven under the terms below, these supplemental loans would carry the same interest and repayment terms as those offered at that time from the Technology Loan Fund.
- The supplemental loans may be forgiven by MIT after the student has completed a period of public service. The period and nature of the public service should conform to the following general guidelines.
- A student who has left MIT and performs a full year of public service will be entitled to supplemental-loan-forgiveness in the amount of two terms of MIT tuition at the time the loan was provided per year of full-time public service. In situations where students did not receive grants, loans and self help as part of a standard financial aid package, the amount of the supplemental loan eligible for forgiveness would be reduced by the standard self-help level offered in aid packages at the time of the loan. Amounts forgiven will include the associated interest on the loan for this amount. If a student who has left MIT performs public service work on a part-time basis, the loan will be forgiven at a prorated level using the full-time level defined above as the base.
- Public service is intended to include such activities as VISTA, the Peace Corps, and K-12 teaching. Alumni and alumnae should contact the Student Financial Aid Office prior to committing to the public service effort for advice on the acceptability of the proposed service. The Director of Student Financial Aid will consult as needed with the chair of CUAFA for guidance on the acceptability of the proposed service.
- Students who choose not to perform public service will be expected to repay the supplemental loan and associated interest charges at the rate as stated in the MIT loan note signed at the time of receipt of funds.

This policy will be further reviewed in the coming year, in response to comments made at the May Faculty Meeting.

CUAFA also conducted regular policy reviews and revisions of practices of the Offices of Admissions and Financial Aid.

The **Committee on the Writing Requirement** met frequently during the 1996-97 academic year, devoting most of its time to developing, refining, and modifying a proposal to the CUP for a new undergraduate communication requirement. The report, echoing the conclusions of earlier reports by the CWR and the CUP's special subcommittee on the Writing Requirement (the Lightman Committee), found that the current Writing Requirement is ineffective in developing MIT students' abilities to write and speak effectively. Consequently, the report recommended replacing the current proficiency-based Writing Requirement with a more substantial and experienced-based Communication Requirement that would integrate instruction in various modes of effective communication into all parts of the undergraduate program.

The Chair of the CWR presented an outline of the proposal at the October Faculty Meeting. Subsequently, the committee in collaboration with the CUP, the Chair of the Faculty, and the Dean of Student Affairs and Undergraduate Education, held several informative and productive discussions on various drafts of the proposal with concerned faculty members, culminating in a January meeting attended by over 30 faculty from all parts of the Institute.

These discussions revealed a consensus among the Faculty that the current Writing Requirement should be replaced with regular and sustained instruction in writing and speaking. These conversations, however, also revealed significant disagreement on several fundamental implementation issues. Recognizing the almost universal approval by the Faculty of the proposal's overall objective, while also recognizing the need to address these unresolved concerns, the Committee on the Writing Requirement modified its proposal to Faculty, requesting that the Faculty endorse its general conclusions and analyses and that the Faculty charge the CUP, in collaboration with the CWR and departments, to conduct two years of pilot programs and curricular experiments that inform the final design of a new Communication Requirement.

In February, both the CUP and the FPC approved and endorsed the CWR's revised proposal along with a enabling motion drafted by the Chair of the Faculty. The report and motion were presented to the Faculty at its March meeting, and in April, the Faculty unanimously approved the motion endorsing the general objectives of a new communication requirement and mandating two years of pilot communication-intensive programs.

Professor Kip V. Hodges ended his term as Chair of the Committee on the Writing Requirement but will continue to serve on the Committee as Dean for Undergraduate Curriculum.

* * * *

Sincere appreciation is extended to the following faculty members for their special contributions and service as appointed Chairs of the Standing and Special Faculty Committees during the past year: J. D. Nyhart (Academic Performance), Charles L. Cooney (Corporate Relations), David K. Royslance (Curricula), Jed Z. Buchwald (Discipline), Lawrence M. Wein (Edgerton Award), Roy E. Welsch (Faculty-Administration), Alice Amsden (Killian Award), June L. Matthews (Library System), Arnolde C. Hax (Nominations), Robert T. Sauer (Outside Professional Activities), Jean P. de Monchaux (Student Affairs), J. Kim Vandiver (Undergraduate Admissions and Financial Aid), Charles Stewart III (Undergraduate Program) and Kip V. Hodges (Writing Requirement). Many thanks to Leigh H. Royden and Samuel M. Allen for their service as Associate Chair and Secretary of the Faculty.

Lawrence S. Bacow, Anna Frazer

SENIOR VICE PRESIDENT, OPERATIONS

While many physical changes to the campus were evident once again this year, perhaps the most striking changes involved new ways of doing business and dramatic changes in personnel brought about by the one-time Retirement Incentive Program. In the operating areas alone, 110 individuals retired, including five long-serving department heads. These changes in personnel necessitated reorganization in some instances and searches for replacements in others.

Steady progress continued on the reengineering front with many processes being redesigned or restructured. As a result of recommendations made by a team assembled to review the publication, copy, and audio visual needs of the Institute, the umbrella Graphic Arts Department ceased operations at the end of August and Copy Technology Services and Audio Visual Services became autonomous departments. On another front, the Office of Facility Management Systems separated from the Institute in September with the Institute's space accounting functions being assumed by the Physical Plant. Finally, in November, as a result of the reengineering of Student Services, responsibility for the oversight of the Campus Activities Complex and Housing and Food Services was transferred to the Dean of Students and Undergraduate Education.

Many physical improvements to the campus were evident as well. Chilled water capacity was greatly expanded at the Central Utilities Plant and additional cooling tower capacity will go on-line early next year. Building 56 was occupied following renovation and the total renovation of Building 16 commenced late in the winter. The renovation of Senior House set a new standard of accomplishment with \$11 million of construction being completed in just 12 weeks during the summer. Exterior work on the building, including a new grand entrance on Amherst Street, will be completed early next year.

Four Institute projects were the recipient of awards during the year. The School of Architecture Renewal project, the Tang Center, and the Cogeneration project won design awards and the Senior House project received an Owner Excellence Award. In addition, the US Environmental Protection Agency named Physical Plant as its "Partner of the Year" for the Plant's dedication to promoting energy efficient lighting.

Affirmative Action efforts continued throughout the year. Our on-going goal is to hire minorities and women, whenever possible, and to promote women in non-traditional roles. We are pleased to be able to report a number of hirings and promotions consistent with these goals. We were successful in hiring an Asian American as a Safety Officer in the Safety Office, an African American utility worker at the Endicott House, and an African American female as the Assistant to the Director of Planning in the Planning Office. As for promotions, an African American male was promoted to Planning Officer in the Planning Office and an Asian female was promoted to Project Manager of Utilities in Physical Plant. In addition, a female recruit will be added to the Campus Police patrol ranks upon the successful completion of training at the Police Academy.

We will continue to strive toward a goal of a more diverse work force.

Following are individual department reports.

William R. Dickson

AUDIO VISUAL SERVICES

As a result of a study by a team of individuals appointed to look at the publication, copy, and audio visual needs of the Institute, Graphic Arts was closed and Audio Visual Services became a department. Outlined below are the highlights of the first year of Audio Visual Services operating as an autonomous department.

The department completed the year by providing service for nearly 6,000 Institute events, including production assistance for presentations in classrooms, international conferences based at MIT, and special events. Student organized and produced cultural and entertainment events were supported with sound and video systems capable of covering up to 500 attendees. These systems, as well as all equipment in the Audio Visual Services inventory, were made available to students at lower prices than those of other local vendors.

Over the past year, the staff of Audio Visual Services was involved in the planning and design of several new presentation systems including A Barco 8100 Graphics computer/video projection system in the 10-250 lecture hall enabling faculty and students to display high resolution computer images on a large screen; the initial design of the School of Architecture and Planning's Advanced Visualization Theater which involved coordination of the department's high resolution computing and teleconferencing needs with a video and amplification system with final installation to be completed next year; and upgrading of several classrooms including 4-370, 10-250, 26-100, and 54-100 undertaken in conjunction with the Registrar's Office.

Requests for computer projection continued to increase and the demand for higher resolution images required the purchase of three new projectors. Other equipment purchased included new VCRs to replace outdated models and UHF wireless microphones for portable use.

During the year, significant progress was made in the development of database programs to process work orders, track equipment maintenance in electronic classrooms, and organize equipment inventories. A World Wide Web based ordering system for services was introduced and used heavily throughout the year.

Further information about Audio Visual Services can be found on the World Wide Web at the following URL:
<http://web.mit.edu/av/www>.

Louis W. Graham, Jr.

CAMPUS POLICE

The MIT Campus Police Department recommitted itself to providing services to the community through partnerships that reduce crime, created a safe environment, built trust, and enhanced the quality of life in the academic community. The department is further committed to delivering quality service to the community in an effective, responsive, and professional manner. As part of this dedication to service, the department has incorporated four values reflecting the qualities of the community: partnerships, integrity, dignity, and excellence.

Although reported thefts of Institute property, personal property, and residence hall thefts dropped during the year, the total number of reported incidents of larceny of Institute property continued to be the largest category of crime on the MIT campus. Crimes against persons increased by one from last year to a total of 26 for the year.

Computers and computer components were, once again, the most frequent type of Institute-owned property stolen. There were 475 incidents of thefts of personal property reported at sites other than residences, compared with 706 last year. Wallets, pocketbooks, compact disc players, and backpacks led the list of articles stolen. Thefts reported inside residences numbered 68 this year compared with 193 last year. Wallets, cash, bicycles, and cameras were the major targets.

Motor vehicle thefts on campus increased slightly. There were 24 motor vehicle thefts this year compared to 19 last year. However, the theft of bicycles dropped significantly from 227 last year to 143 this year.

The Safe Ride safety shuttle service provided 137,230 personal safety escorts during the year. Campus Police also supplemented Safe Ride when early morning operations ceased by providing 839 personal safety escorts in police cruisers to members of the community.

The Rape Aggression Defense (RAD) self-defense program continued to be a popular course. During the year, the program increased the total number of persons trained to 296 since the start of the program in 1994.

More information about this department, its services, operations, and campus crime can be found on the World Wide Web at the following URL: <http://web.mit.edu/cp/www/>.

Anne P. Glavin

COPY TECHNOLOGY CENTERS

The current year has been one filled with change for the Copy Technology Centers. During the year, the Graphic Arts department, of which the copy centers were a part, was closed. As a result of a proposal by a review team, the various copy-related services were merged into a new department. The goal of this newly formed organization is to provide the community with the highest quality copier and copier related services.

The newly configured Copy Technology Centers debuted during the year. The primary focus was to maintain a high level of service delivery, to merge the fragmented copy operations into one, to establish partnerships with both inside and outside groups, and to slowly integrate a number of new services and features into the organization.

A number of key accomplishments were achieved during the year. A concerted effort to address the needs of MIT students resulted in extended evening hours, Saturday openings, new payment choices using student ID cards and/or credit cards, and improved copy facilities. Renovations to Room 11-004 brought together several copy services as well as accounting services into one central location. During the year, extensive training was provided to staff in all areas of the organization on computer and network services as well as preparation for the implementation of the upcoming SAP accounting system. A partnership with DHL Shipping was introduced during the year and space was provided in the 11-004 center for an overnight package delivery service.

This year the department closed with an income of \$3 million, a 13 percent increase over the previous year. The centers look to the year ahead with confidence, enthusiasm, and high expectation.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/ctc/www/>.

Steven M. Dimond

ENDICOTT HOUSE

During the year an assessment of the organizational and operational changes necessary to meet Endicott House's future role within MIT and improve the center's financial position was conducted. Over the past five years, Endicott House experienced a reduction in business volume due to the shrinkage and final termination of the Sloan School's Senior Executive Program, a lessening in general conference business, and an increase in competition. It was determined that, for Endicott House to reach its former position of stability, three key issues needed to be addressed: acquiring the marketing expertise necessary to increase sales, recruiting a General Manager due to the retirement of Howard Miller, and restructuring of the existing organization.

In an effort to realize the aforementioned goals, Conference Center Consulting Group was retained on a term basis to assume responsibility for sales and marketing. Their goal is to increase sales and client awareness among both MIT clients and external clients.

As a result of Mr. Miller's retirement, a search committee was appointed to locate an individual with hospitality experience possessing a strong background in conference center management, specifically estate properties. In April, Michael Fitzgerald joined the Endicott House staff as General Manager, bringing over 22 years of industry experience, including managing three estate conference center properties.

Under Mr. Fitzgerald's guidance, a reorganized operational structure, a capital reinvestment plan, an increase in marketing activities, and an improved level of client services are being implemented. These steps have begun to yield results.

This year Endicott House hosted 65 overnight conferences of which MIT groups accounted for 20. This reflects a 16 percent increase in conferences over the previous year. Day conferences experienced dramatic growth with 113 conferences hosted of which 33 were MIT groups. Guest nights increased to 5,099 from 3,723 the previous year. The annual occupancy increased to 38 percent, a ten point increase over last year. The expectation for the coming year is an increase in growth yielding 6,970 guest nights and a 52 percent occupancy rate. In meeting these objectives, Endicott House will return to a prestigious and strong financial position.

Michael Fitzgerald

INSURANCE AND LEGAL AFFAIRS

The Office of Insurance and Legal Affairs serves the Institute's needs for addressing property and casualty insurance exposures and claims and in responding to a variety of legal issues.

During the year, the Institute suffered two substantial losses at its new Cogeneration Facility. The two failures represent a combined loss of \$2.8 million. Technical analysis of the failures is still being conducted to determine the extent of reimbursement that will be afforded under MIT's blanket property insurance policy and to explore the subrogation potential against the manufacturer of the gas turbine.

Heavy rains during the year caused extensive damage in two areas of the campus with losses incurred in excess of \$850,000. A chemistry lab in Building 2, filled with lasers and electronic equipment, was hit the hardest with damages of \$760,000. The Parsons Lab, Building 48, also suffered major damage.

Additional property losses throughout the year totaled \$105,838, of which 56 percent were attributed to computer thefts. Premiums for all lines of insurance remained level during the year within a budget of \$3.3 million.

Two major lawsuits filed by MIT were settled during the year. MIT's claim against Lloyd's of London, for failure to reimburse the Institute for legal expenses incurred in the defense of the anti-trust lawsuit, was settled for \$4,925,000. The Office of Insurance and Legal Affairs also assisted the Technology Licensing Office in settling a claim based on a patent license.

Insurance coverage was provided for several employment-related claims, totaling over \$1 million, including legal defense.

Over 100 students were provided guidance for a wide spectrum of legal-related problems or questions.

Thomas R. Henneberry

PHYSICAL PLANT

This year marks the third year of reengineering in Physical Plant. Progress continues toward securing the department vision of a commitment to delivering excellent customer services in facilities, communications, timeliness, quality, cost, and safety. To ensure continued progress, the year's efforts included communications planning, customer service training, leadership redesign, learning and performance initiatives, information technology upgrades, and best practices research.

OPERATIONAL UNITS

Building Services has completely transitioned into a team-based operation and team members are more comfortable with the team approach. A custodial performance report for each of the 26 custodial teams was developed and implemented. The report is used by teams to track their monthly progress. Computer training for custodians is continuing.

Over the past year, Grounds Services has completed the redesign portion of its reengineering effort. The pilot, planning, and implementation segment is scheduled to begin early next year. Over the next year, the department's goal is to complete the planning, implementation, and roll out process.

Mail Services now offers more services to the community and the standards for delivery are higher than before reengineering. All Distributed Mail Centers (DMC's) are on-line, thereby completing the redesign of delivery of mail. At present, all US Mail is delivered within eight hours of receipt. The department has incrementally taken on the task of handling outbound mail for the departments, labs, and centers, processing approximately 50 to 70 percent of all outbound mail. This year \$31,000 has been saved in domestic postage and \$145,000 in international postage on daily mail from offices.

All Repair and Maintenance local zone and central teams have been rolled out. Fine tuning these teams is currently underway with the goals of better customer service, faster response time, timely repairs, silent work, lower costs, and better maintained spaces and systems. The Repair and Maintenance Team is beginning to move some previously subcontracted work in-house.

ENGINEERING, DESIGN AND CONSTRUCTION

Chilled water capacity was expanded at the Central Utilities Plant (CUP) as a new 5,000 ton steam turbine driven chiller commenced operation this year. The chiller uses waste heat steam from the cogeneration process to drive the turbine. An additional cooling tower is also nearing completion. The chilled water distribution system was extended to provide air conditioning to Senior House. Additions and replacements were made to improve reliability of the electric system including installation of a 2400 volt switchgear tie in the CUP and 13.8 kV oil switch and 480 volt main breaker replacements at various points in our distribution system. The Institute continues to appeal the DPU order to pay exit fees for leaving the local utility system upon the opening of the cogeneration plant. A decision is pending on this from the Massachusetts Supreme Judicial Court.

The US Environmental Protection Agency named Physical Plant as "Parnter of the Year" for the Plant's dedication in the promotion of energy efficient lighting through superior lighting upgrades and educational and promotional efforts.

The staff in the Design and Construction section managed a total of 171 new projects, including 79 space change projects, 8 new construction/major renovation projects, and 84 interior design projects. In addition, there were many other projects such as feasibility studies, graphics projects, landscape design projects, ADA renovations, and sprinkler projects.

This year more design awards were won than any other year in recent memory. Three Boston Society of Architects Honor Awards for design excellence were awarded as a result of projects in the School of Architecture, the Tang Center, and the Cogeneration Plant. In addition, the Associated General Contractors and the Boston Society of Architects jointly awarded an Owner Excellence Award to the MIT Senior House team.

Some highlights of new construction or major renovation projects included:

- Building 56 opened on schedule and was fully occupied. Interior demolition in Building 16 commenced immediately after the building was vacated and occupancy is scheduled for March of 1998.
- The fourth phase of the School of Architecture was occupied, including the new Cafe at the Dome which enjoys great success as a popular gathering spot for students and faculty. The next phase of miscellaneous alterations in Buildings 3 and 10 will be completed next year.

-
- Senior House set a new standard for MIT; \$11 million of construction was put in place in three shifts during 12 weeks of the year. Exterior work on the building, including a new entrance on Amherst Street, which will be completed next year.

MANAGEMENT INFORMATION SYSTEMS

The Management Information Systems (MIS) team continues to support the Physical Plant reengineering efforts by participating in the design and roll out of the new processes. The team implemented and provided training for Maximo, a new I/T system to track work within the reengineered Repair & Maintenance process. Planning for and implementation of the transition to SAP is well underway.

In addition, several enhanced PC and Macintosh programs have been developed for use by Plant employees. The development and maintenance of CAD facility drawings of campus-wide and internal building systems also continues.

The MIS team has continued to deploy desktop computers for use by all members of the organization. There are now almost 300 desktop computers in the Plant for use by administrative, support, and hourly staff. This small group continued to work diligently and effectively to sustain the momentum of developing a computer literate department.

RECYCLING AND REGULATORY MEASURES

Recycling continues to expand throughout campus. Presently the recycling rate is approximately 11 percent. The Institute is continuing to abide by the ever changing regulatory requirements of the local, state, and federal government agencies.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/plant/www/index.html>.

Victoria V. Sirianni

PLANNING OFFICE

This year, the Planning Office undertook a wide range of Institute planning projects. Some of the accomplishments are listed below.

Continuing revision of the most active elements of the MIT Capital Development Program (the extensive inventory of MIT's capital projects, their estimated costs, and their location on the campus) was an important part of support provided by the Planning Office with regard to the emerging development plan initiated to update the underlying financial models based on changing institutional and market economic conditions. This document provides a comprehensive picture of MIT's capital needs and their implications for land and financial resources for the next 10 to 15 years, and is a key resource for all new on-campus building initiatives.

The Planning Office also provided continuing support to Resource Development in preparing fund-raising program materials for the proposed addition to the Media Laboratory; the Computing, Information, and Intelligence Sciences (CIIS) building; a new facility for Brain and Cognitive Sciences; and a proposed Center for the Performing Arts.

In an attempt to complete the land assembly for the east campus, efforts continue to acquire the former City fire station at 350 Main Street in Kendall Square.

Progress continues in support of two major roadway improvement initiatives which began two years ago. The first involves the Memorial Drive/Massachusetts Avenue intersection where new signals and turning lanes will improve pedestrian safety and traffic movement. The second, reconstruction of Massachusetts Avenue from Memorial Drive to Lafayette Square, will improve both safety and aesthetics along this major transportation artery. In addition, the Massachusetts Avenue reconstruction will include support for increasing the use of bicycles as a commuting option.

Parking on campus remains an issue of great concern. The Planning Office provided the staff support for an ad hoc task force charged with conducting a review of policies and making recommendations for change as well as continuing to provide staff support for the Institute's Parking and Transportation Committee.

Support of the Athletics department continued this year with the development of plans for improved tennis facilities, expanded rowing facilities, and improved security around the outdoor fields. The office also continued to provide support for the development of the final elements of the Central Athletic Facilities Plan.

Progress continued on a comprehensive housing plan which would lead to the near-term development of graduate housing in the Albany and Sidney Street areas. An urban design study is underway with construction expected to begin next year. In addition, the Planning Office staff is exploring ways of stimulating MIT and private sector partnerships designed to increase the housing inventory available to the MIT community.

The office continued to provide planning and staff support to the Office of Government and Community Relations, the Real Estate Office, and Physical Plant's Space Administration section. In addition, the office continued to produce a variety of materials during the year in support of academic planning.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/planning/www/>.

O. Robert Simha

PURCHASING

Procurement partnership arrangements, which began last year, continued this year as a result of supplier consolidation efforts. Partners include VWR Scientific, BOC Gases, Office Depot, Sterling Olsten, and a new partner, DHL Shipping. Efforts in closing the MIT Computer connection (MCC) commenced with an RFP to suppliers. The transition with the selected partner, NECX, will begin early next year. Additional partnerships will form as a result of the creation of the Publishing Services Bureau.

The conversion of data from the VAPS system to the SAP system was accomplished during the year and SAP became the system of record for the Comptroller's Accounting Office (CAO) and Purchasing. A major effort involved communications throughout the community. Monthly luncheons that were open to the community were scheduled to try and identify and resolve problems. Another effort which was shared by both the CAO and Purchasing were visits directly to departments, labs, and centers to inform them of procedural changes and to listen to their concerns. Both efforts have proven very useful and appreciated by the community.

The vendor file was reduced from 40,000 to 18,000 with the migration to SAP.

The Electronic Requisitioning System (EREQ), the Institute's on-line and interactive electronic requisitioning system, remains available to all members of the MIT community and will be available until all departments have been trained and converted to SAP.

This year, there were more than 205,000 transactions generated to view the status of business, to create 46,702 electronic requisitions and speed orders to outside vendors, and to create 16,649 electronic requisitions to Institute internal providers.

The Electronic Catalog System (ECAT), a World Wide Web based ordering system, went into production during the year. At year end, approximately 300 accounts had been established with 100 active users. The numbers continue to grow each month.

Approval was granted for the MIT Visa Purchasing (VIP) Card. A pilot for the card is scheduled for early next year.

Subcontracting Plans are required by law for each contract proposal to a federal agency which exceeds \$500,000. The Subcontracting Plan must specifically identify the efforts that will be taken under a resulting contract to assure the award of a fair proportion of subcontract and purchasing dollars to small business and small minority business concerns. Each Subcontracting Plan includes both dollar and percentage goals which are negotiated with the sponsor and become a material part of the resulting contract.

As a service to departments, laboratories, and centers, the Assistant Director for Subcontracting coordinates this effort with the Office of Sponsored Programs and the affected principal investigators. He then prepares Subcontract Plans for submission, negotiates changes when necessary, and reports accomplishments to federal sponsors and principal investigators. This year, there were over 50 active Subcontracting Plans under Institute federal contracts which necessitated the submission of over 100 separate reports of accomplishments to federal sponsors.

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/purchasing/>.

Diane Shea

SAFETY OFFICE

The Safety Office provides advice, counsel, and programs to the MIT community which promote a safe environment. The office also implements safety-related functions to ensure compliance with Institute policies and government legislation.

High voltage training, in conjunction with Boston Edison, was conducted at Lincoln Laboratory, Haystack, LINAC, and in Physical Plant. The Lincoln Laboratory Safety Office was the first to develop and offer this effective program and the MIT Safety Office followed suit. The program received praise by the high voltage electricians attending.

A Fire and Emergency Response Team (FERST) for the campus is still being evaluated. During the year, a significant amount of information relative to having such a team has been accumulated.

An *Ad Hoc* Environmental Committee was formed by the Safety Office and the Industrial Hygiene Office to explore and act upon Institute environmental concerns. Work continues in this area.

Demolition of Building 16 brought with it some hazardous waste and disposal issues related to drain piping that caused MIT to review and consider new procedures so that we would remain both environmentally conscientious and economically efficient.

Lecture bottle disposal alternatives are being pursued and evaluated. The inventory indicates that there are over 500 lecture bottles to dispose of campus wide.

During the year, MIT contracted with a new insurance carrier for Highly Protected Risk (HPR) and Boiler and Machinery (BM). A Thorough inspection of the various mechanical and fire protection systems of the entire campus was conducted by an inspector from the insurance carrier and a representative of the Safety Office.

This year, new emphasis was placed on off campus sites. Talbot House is in the process of being retrofitted with a special fire protection sprinkler system which will be remotely monitored on campus. Life safety inspections were carried out at Talbot House and an emergency action plan established.

Haystack has developed an active safety committee with some counseling and inspections being provided by the Safety Office. Ongoing assessments continue. Bates LINAC also had safety visits during the year.

The Department of Environmental Protection (DEP) project is near completion. This was done with input from the Safety Office and Industrial Hygiene Office in cooperation with departmental chemical hygiene officers to ensure compliance with DEP hazardous waste regulations. A contractor was hired to install signs and trays, provide a DEP-type mock inspection, provide training, and check manifest records.

Workers' compensation continues to show an increase in Repetitive Strain Injuries (RSI) despite active and aggressive RSI prevention activities. The RSI Committee, the Medical Department, EMS, and the Safety Office continue to address these issues.

Overall Institute safety needs and regulatory impact continue to be evaluated and programs developed to fill those needs. Ongoing assessments, planning, adjustments, and compliance program development remain a high priority. The Safety Office will continue to work towards a more visible and involved presence in the community.

W. Jerry Diaz

SECRETARY OF THE CORPORATION

The Secretary of the Corporation serves as the Corporation's Recording Officer and as joint signatory with the President in the awarding of academic degrees. The Office of the Secretary of the Corporation is responsible primarily for providing support to the Institute's governing board and to 26 Corporation visiting committees.

CORPORATION MEETINGS

On October 3, 1996, an orientation program was held for new members of the Corporation. In the evening, new members and their spouses and guests were joined by the Executive and Membership Committees for a reception and dinner.

At the annual meeting on October 4, 1996, new members were introduced, and a report was made on the search for a new Chair of the Corporation. The Corporation approved the action of the President in the awarding of September degrees, and voted to approve the list of nominated members of the visiting committees. Louis W. Cabot transferred to the status of Life Member Emeritus. The report of the President included presentations by Professor Robert A. Brow, Dean of Engineering, and Professor Glen L. Urban, Dean of the Sloan School of Management. Members also heard reports from the Treasurer, the Vice President for Resource Development, and from the chairs of the Auditing Committee, Membership Committee, Salary Subcommittee of the Executive Committee, and five visiting committees.

On December 6, 1996, the Corporation approved the nomination of Alexander V. d'Arbeloff as Chair of the Corporation, effective July 1, 1997. The Corporation also approved a new Master's degree program in Geosystems in the School of Science, and voted to send a resolution of thanks to Institute Professor John M. Deutch for his national service. Members heard reports from the President, the Provost, and the chairs of the Community Service Fund, Membership Committee, and four visiting committees.

On March 7, 1997, the Corporation approved the action of the President in the awarding of February degrees. Professor Philip S. Khoury, Dean of Humanities and Social Science, and Professor Robert J. Birgeneau, Dean of Science, made presentations as part of the report of the President. Additional reports were presented by the Vice President for Resource Development and the chairs of the Corporation Joint Advisory Committee on Institute-Wide Affairs, Membership Committee, Screening Committee, and three visiting committees.

The final quarterly meeting of the academic year was held on June 6, 1997, prior to Commencement exercises, at which the speaker was The Honorable Kofi A. Annan, Secretary-General of the United Nations. The Corporation approved the action of the President in the awarding of June degrees, and approved the establishment of a new Master of Engineering degree in Logistics. The Corporation elected new Corporation members, members of the standing committees and committees of annual recurrence, chairs of the visiting committees, and approved nominations for membership on the Corporation Development Committee. Resolutions were read to honor eight members completing their terms of service on the Corporation, and a resolution presented by former President and Chairman of the Corporation Howard W. Johnson honored outgoing Chairman Paul E. Gray. Christian J. Matthew transferred to the status of Life Member Emeritus. Retiring Chair of the Faculty Lawrence S. Bacow addressed the membership, and members also heard reports from the President and the chairs of the Membership Committee, Screening Committee, and three visiting committees. Corporation members participated in the academic procession to Killian Court for Commencement exercises, with Christian J. Matthew servicing as Corporation Marshal.

CORPORATION MEMBERSHIP

Completed Service Effective June 30, 1997: Pedro Aspe, Gerald J. Burnett, Alan B. Davidson, Robert S. Horton, Nannerl O. Keohane, William B. Lenoir, Robert M. Metcalfe, and Romano Prodi.

Leave of Absence: Shirley A. Jackson, Life Member, leave of absence for government service continued.

Elected to a Five-Year Term Effective July 1, 1997: Gregory K. Arenson, Norman E. Gaut, Osie V. Combs, Jr., Lissa A. Martinez, DuWayne J. Perterson, Jr., Gerhard H. Schulmeyer, Elisabeth A. Stock, Susan E. Whitehead, and Robert E. Wilhelm.

Elected Life Member Effective July 1, 1997: Paul E. Gray, George N. Hatsopoulos.

Ex officio Member for One-Year Term Effective July 1, 1997: Robert M. Metcalfe, 1997-98 President of the Association of Alumni and Alumnae of MIT.

Transferred to Life Member Emeritus: Louis W. Cabot (October 1997), Christian J. Matthew (June 1997).

CORPORATION COMMITTEES

D. Reid Weedon, Jr., continued as Chair of the Advisory Committee on Shareholder Responsibility, with Vice President for Finance and Treasurer Glenn P. Strehle serving as an *ex officio* member. The committee membership included Senior Vice President William R. Dickson as well as faculty and students. Elizabeth T. Harding provided staff support.

The committee met once on April 14, 1997, and conducted two telephone polls. Members voted on 17 resolutions submitted to ten companies whose stocks are held by MIT in its general investments. Issues were spread over a spectrum of topics with the focus mainly on the environment and human rights abroad. Compared to 1996, the number of resolutions increased by three, and the number of companies involved increased by four.

Auditing Committee Meetings were held on October 3, 1996, and on March 6, 1997. Attendees at the meetings included Auditing Committee members; representatives from Coopers & Lybrand, MIT's independent public accountants; and MIT Audit Division and Finance personnel and other invited members of the MIT administration.

Financial statements for fiscal year 1996 and changes therein mandated by the Financial Accounting Standards Board were discussed at the fall meeting. At the spring meeting, the MIT Audit Division reviewed its prior year activities and its plans for audits for the current year; Coopers & Lybrand presented its audit plan for fiscal year 1997; the committee discussed the implications of currently marking to market the portfolio of marketable securities held in endowment and other funds and the reflection of pledges as current income, subject to reserves in reporting MIT's current operations. The committee was apprised of the conclusion of the IRS audit dealing with research and teaching assistants, and discussed the ongoing implementation and expansion of the new SAP financial system.

During the academic year 1996-97, the Corporation Joint Advisory Committee on Institute-Wide Affairs (CJAC) held three meetings. In October, Professor Robert J. Silbey discussed the work of the presidential Task Force on Student Life and Learning. Additional student guests were invited to the December meeting, which featured a roundtable discussion centering on issues of diversity, student/faculty relationships, academics and residential life, and extracurricular activities. The meeting in March brought together approximately 30 students and members of the Corporation for lively conversation in an informal supper setting. CJAC will continue to foster interaction among students, faculty, and Corporation members in the year ahead.

The Development Committee is covered in the annual report of the Vice President for Finance and Treasurer.

During the past year the Executive Committee held nine meetings, during which it considered such matters as financial planning and budgeting, management of the endowment, results of the retirement incentive program, relations with government and industry, reengineering activities, progress on the new financial management system, changes in the senior administration and in the chairmanship of the corporation, affirmative action and diversity, and new directions in education and research.

The Investment Committee held three regularly scheduled meetings during fiscal year 1997. The Wellington Management Company of Boston remained the primary investment manager and advisor for publicly traded securities, both domestic and international. The Institute continued the program, managed by four other investment management firms, of equity investments in smaller capitalization companies. The program for domestic and international alternative investments to publicly traded securities has been expanded. 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.

The Membership Committee held three meetings during the academic year to discuss and make recommendations concerning membership on the Corporation and on the various Corporation standing committees and committees of annual recurrence.

The Corporation Screening Committee for Nomination of Recent Graduates held an open meeting for students on October 3, 1996. Two teleconferences and two committee meetings were held in January and February 1997. The committee selected nine nominees from a group of 73 candidates for the ballot. Elisabeth A. Stock '90 received the nomination and was elected to serve a five-year term on the corporation.

Fourteen visiting committees convened during the academic year 1996-97: Aeronautics and Astronautics; Biology; Brain and Cognitive Sciences; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Economics; Electrical Engineering and Computer Science; Humanities; Libraries; Music and Theater Arts; Ocean Engineering; Political Science; and Undergraduate Education and Student Affairs.

In 1996-97 the Institute's 26 visiting committees were comprised of 393 persons and 485 membership positions; 65 Corporation members filled 150 slots; 177 presidential nominees filled 183 slots; 151 alumni nominees filled 152 slots. (Two people each filled both a presidential nominee slot and an alumni nominee slot.)

Women comprised 20 percent of the visiting committee membership, and minorities 14 percent; 68 percent of the members were affiliated with corporations; 26 percent with academia, 3 percent with government, and 3 percent with foundations.

PERSONNEL CHANGES

Jennifer N. Carroll left MIT in August 1996 to attend graduate school. Guillet Rivera joined the Corporation Office in mid-August 1996. Rachel S. Rowe departed in January 1997 to travel and subsequently attend graduate school. Karen S. Chini came into the office in April 1997, and Ms. Rivera was promoted to Administrative Assistant in June 1997.

Kathryn A. Willmore

VICE PRESIDENT FOR FINANCE AND TREASURER

In fiscal 1997, revenues and funds were \$1,181.7 million, and operating expenses were \$1,186.6 million. The resulting need for additional general funds of \$4.9 million will be met by using Research Reserve investment income and decapitalizing a portion of Reserve principal.

The Institute continues to tightly control costs and has been engaged in a reengineering effort during the last four years. In financial operations, this effort is focused on management reporting affecting all fiscal accounting procedures. The R3 financial accounting system developed by SAP AG in Walldorf, Germany was selected to replace the present applications, and Phase I was implemented in fiscal 1997. Effective September 3, 1996, SAP became the accounting system of record for the Institute.

With the implementation of Phase I, most of the financial operations staff previously dedicated to the Management Reporting/Financial Operations Reengineering project have either returned to their home departments or transferred permanently to the project. These transfers included staff from the Controller's Accounting Office, Audit Division, and the Office of Budget and Financial Planning. The financial operations staff is continuing training in the use of the new SAP system.

Implementation of Phase II of the SAP system which involves training personnel in the departments, laboratories and centers has begun. The objective is to have SAP fully utilized throughout the Institute by fiscal 1999.

The staff involved in the SAP project share a sense of pride in their accomplishments during this very challenging process. I appreciate their cooperation and their full commitment to assuring that the Institute will achieve the goals set for improving our financial systems and simplifying administrative processes.

The staff planned for the accounting changes implemented this year because of the requirements of FAS 124 and the new Audit Guide.

The following reports by the Audit Division, Controller's Accounting Office, Lincoln Fiscal Office, Property Office, Office of Budget and Financial Planning, Office of Sponsored Programs, and MIT Press will highlight the activities in their respective departments during the year.

Over the past year, each department has addressed its staffing needs following transfers to the reengineering project, acceptance of the early retirement incentive, the startup of new initiatives, and normal turnover. As noted in the past, only half of the positions held by early retirement incentive retirees are being filled with permanent staff. There have been opportunities for staff to assume new or expanded responsibilities, to be promoted into supervisory roles and to learn new skills. At year end, women represented more than 59 percent of our employees, and minorities 10 percent. We continue our efforts to diversify our workforce. Hirings and promotions of women and minorities occurred during the year and there were a number of promotions into staff positions from support. We anticipate that this process will continue, in keeping with our commitment to the Institute's affirmative action program.

Glenn P. Strehle

AUDIT DIVISION

As the Institute continues to experience the challenges and opportunities of major administrative process restructuring, the Audit Division has remained actively involved with most initiatives. Over the past two years, we have invested over 30 percent of our audit resources to addressing critical control issues and collaborating with others to determine effective operational approaches to our rapidly changing environment.

Internal Auditing is an integral part of MIT's internal control structure. We maintain the flexibility to respond to the needs of management by both addressing targeted audit areas identified by management and audit staff, and by assessing risk. We continue to serve the Institute in accordance with the stated mission of providing reasonable assurance to management that Institute policies are being adhered to as intended, adequate internal controls are being maintained, and assets are properly safeguarded. The last two items are of critical importance

during these times of dramatic change created by various reengineering efforts. Policy changes will result in further Audit Division attention but are secondary to maintaining a solid internal control environment and protecting the assets of MIT. We fulfill our role through reviews, both on campus and at Lincoln Laboratory, which encompass diverse aspects of MIT operations.

Our audit coverage is coordinated with Coopers & Lybrand, the Institute's Certified Public Accounting firm, and the Defense Contract Audit Agency (DCAA), MIT's cognizant Federal audit agency. Internal audits are conducted consistent with the *Standards for the Professional Practice of Internal Auditing* which guide us in the discharge of our duties to ensure proper objectivity, independence and audit quality control.

Compliance with governmental regulations has been a focus of audit attention for many years. Our departmental review efforts to verify proper financial accountability and evaluations of environmental health and safety regulations continue to represent a significant portion of our annual audit plan. Additional compliance efforts address conflict of interest disclosure requirements, sponsored research cost sharing requirements, and compliance with OMB Circular A-21 guidelines relating to direct charging of administrative support costs to sponsored research.

We have developed a solid expertise in the auditing of construction projects. Those contracts that are based on actual costs rather than fixed price agreements are most important to analyze for errors and inappropriate charges. We will work with those responsible for construction oversight to help ensure ongoing financial accountability in addition to fulfilling their traditional project management responsibilities.

SAP now serves as the foundation for Institute financial reporting and control, impacting every department, laboratory and center. Initial implementation hurdles within central administrative areas have been addressed and further roll out to the community is now underway. Other significant information technology attention includes the ongoing development of a comprehensive electronic records management program and the Year 2000 impact on MIT information systems.

Charles A. Shaw

OFFICE OF THE CONTROLLER CONTROLLER'S ACCOUNTING OFFICE

Fiscal 1997 was a year of change for the Controller's Accounting Office (CAO) and the Institute due to the implementation of SAP - Business Process Software.

On September 3, 1996 the MIT financial system of record was transferred from our classic system to SAP. This was the first phase of the implementation plan for the integrated software system which included the general ledger, accounts receivable, accounts payable, travel and sponsored billings. The second phase will proceed during fiscal 1998 which will include installing SAP as the financial system for the departments, laboratories, and centers as well as employing additional functionality to processing in Phase I such as reporting.

The conversion to SAP has caused the accounting units in CAO to work in two systems. The MIT community continued to view its financial results in reports from the classic system. This was accomplished by transferring data from SAP to the classic system. During fiscal year 1998, we will be working with the Reengineering Management Reporting and Financial Operations teams and the MIT community to fully convert to SAP. Once this is finished, the community will be receiving their financial information directly from SAP.

The Payroll Office is responsible for the accounting, distribution, and payment of salary and wages to all MIT employees and students. The pilot program to allow departments to send graduate student appointments electronically to the Payroll Office was completed.

The Internal Revenue Service (IRS) employment tax audit for calendar years 1985 and 1986, carrying an \$18 million assessment against MIT, was dismissed by an IRS Appeals Officer in favor of MIT, ending a nine and one-half year process. Similar audits for calendar years 1987 through 1990 that had begun are now on hold pending an

evaluation by the examining agents in light of the 1985-1986 decision. The Coordinated Examination Program (CEP), controlled at the national level as opposed to the other audits which were conducted by the regional IRS office, is still in progress for 1991 and 1992, and is reviewing the same issues.

Payroll Office personnel have begun an intensive project to insure that the Payroll System will be full Year 2000 compliant by the end of 1998. Another major project was started to ensure that Research Assistant tuition awards will automatically follow the Research Assistant salaries. This will be completed before June 1, 1998. The decision was made that the payroll system was the place best suited to ensure compliance with OMB Circular A-21.

The Benefits Accounting Office (BAO) is responsible for the accounting for the Employee Benefits provided by the Institute to its employees.

All efforts were devoted to handling the extraordinary additional requirements to implement the Early Retirement Incentive Program. That effort included the development of a "lump sum modeler" by the actuaries that required the involvement of the BAO personnel to define and test. Efforts are underway to work with the actuaries to modify this system so that it can be used as a processing and counseling tool as part of our regular business process.

PROPERTY OFFICE

The Property Office is responsible for the accounting and asset management of more than 100,000 items of equipment which are both MIT-owned as well as sponsor-owned. During the year, 15,400 newly acquired items of moveable equipment were identified and tagged. Over 15,000 financial transactions regarding invoices, purchase orders, requisitions, journal vouchers, and cash vouchers were reviewed resulting in 3,200 corrections thereby ensuring the integrity of the Property Data Base. The reconciliation of the equipment biennial physical inventory was completed and a new inventory cycle was begun. Two hundred ninety-eight final inventories were submitted as part of closing out contracts, grants, and agreements; 540 financial reports prepared and submitted to various government agencies; 334 items of excess government equipment with an original acquisition cost of \$1,697,797 were acquired; and 712 items of equipment with an acquisition value of \$534,000 were transferred between MIT departments as part of a reutilization program.

Thirty-four capital projects were begun during the year. The costs of capital space changes, major renovations, and new building construction continue to be tracked. The successful deployment to the MIT community of SumPROP, the electronic Property Application, enables users to query and report on equipment data and reduces requests for special reports.

LINCOLN FISCAL OFFICE

The Lincoln Fiscal Office (LFO) provides the accounting, accounts payable, accounts receivable, reporting and property support to Lincoln Laboratory.

The completion of automation of the Technical Certification System which eliminated the need for paper copies has speeded up the payment cycle for all invoices. Modifications to the Accounts Payable and Automated Purchasing System to process excluded procurements from Department of Defense programs and allocated programs outside the fiscal 1997 ceiling were completed. A new laser Flexible Reimbursement Account Plan (FRAP) check has been designed and implemented.

A request for restructuring the Lincoln Laboratory Advance Payment Pool Agreement has been sent to the Office of the Secretary of the Air Force. LFO is working with the Office of Sponsored Programs, the Treasurer's Office, and CAO to convert the Lincoln Payment Pool for both Lincoln Laboratory and the MIT Campus. Continued progress has been made on the reconciliation of the Property Control System; the yearly 1,662 property procedure and inventory was completed; and a new Ship Order System is being developed with completion expected in the second quarter of fiscal 1998.

More information about this department (CAO) can be found on the World Wide Web at the following URL:<http://web.mit.edu/cao/www/>

James L. Morgan

OFFICE OF BUDGET AND FINANCIAL PLANNING

The Office of Budget and Financial Planning supports MIT's goal of continued excellence in education and research by providing senior management with accurate and timely financial information, projections and recommendations; monitor's the Institute's financial position and the likely impact of anticipated changes, both internal and external; manages the financial information asset as a critical component of the Institute's strategic planning process; and executes operating and capital programs.

Strategic objectives for the office include the following:

- Introduce innovative budgeting and financial planning tools to simplify the collection of financial information, improve its quality and enhance its accessibility at all management levels.
- Help improve the budget process to shorten its cycle and improve its timeliness.
- Complete the development of operating budget models to support the Provost and senior management in their effort to monitor and reduce the current deficit.
- Facilitate the implementation of new systems and processes that result from the various reengineering initiatives.
- Revise the Office of Budget and Financial Planning (OBFP) organizational structure to better utilize resources and enhance responsiveness to the Institute's changing needs.

Over the past year, OBFP has been facing the demands of a rapidly changing environment. In addition to our traditional role as a consolidator and reporter of operating and capital budgets, we have been increasingly involved in the development of modeling tools to support longer term financial planning. The first such tool, a spreadsheet-based model of the operating budget which projects resources and expenses over a ten-year time frame, has just been completed. Over the next several months, it will be further refined to allow more complex scenarios based on a growing set of variables. Another tool, a set of flowcharts mapping the Institute's external and internal cash flows, will be completed shortly. A third tool, a new Capital Budget Report, was presented to Senior Management last spring and includes an overview of construction spending and operating impact for each active and future capital project over a ten-year time frame. This report will be published at regular intervals to keep Senior Management informed of changes to the capital plan and any resulting changes in the operating budget. Finally, a Monthly Budget Report (MBR) was introduced last fall. The MBR, published monthly from October through June, includes an overview of income and expenses, as well as detailed schedules and graphs for salaries, gifts, tuition, sponsored research support and risk items.

To meet the new challenges, OBFP has recently adopted a more flexible structure, with teams organized around deliverables. Some are the traditional deliverables inherent in our role, such as the operating and capital budgets. Others are related to the new tools and systems under development. Yet others relate to our less tangible but equally important support role, such as communication with the schools and participation in school or departmental special studies.

Over the next year OBFP, in close cooperation with the Reengineering Team, will deliver a new Institute-wide budget system compatible with the SAP financial system, to replace the existing BEERS system. As indicated above, our goal is to develop innovative budgeting and financial planning tools to simplify the collection of financial information, improve its quality and enhance its accessibility at all management levels. We are also in the early stages of developing our web page. Eventually, we would like this page to include both office-specific information, such as a list of team members, and financial information that might be helpful to the community.

Stefano Falconi

OFFICE OF SPONSORED PROGRAMS

For fiscal 1997 the total volume of sponsored research performed on campus was \$367.3 million. This represents an increase of 2.4 percent over fiscal 1996 volume of \$361.7 million. The breakdown by sponsor is shown in the table at the end of this report.

Activities in the Office of Sponsored Programs (OSP) during 1996-1997 were impacted in two distinct arenas: externally by ongoing policy issues related to federal funding of research and internally by the continued development of a major new emphasis on computerization and automation within the office. Each of these is described below.

FEDERAL INITIATIVES

Adopted in May, 1996, another set of proposed revisions to OMB Circular A-21 (the Federal cost principles applicable to universities) were issued which included provisions that further constrain the ability of institutions to fully recover the costs of performing research for the federal government. Further revisions are expected to be issued which are scheduled to be effective in Fall 1997.

One of the significant changes adopted in 1996 is the requirement to "fix" the indirect cost rate for the life of an award or competing segment thereof. This has placed additional strain on resources to accommodate multiple indirect cost rates and has led to significant interaction with researchers and federal agencies to implement this change fairly and equitably.

With the implementation of Cost Accounting Standards and more rigid interpretations by federal auditors, issues surrounding cost-sharing are now creating additional areas of possible audit activity in the research arena. Stated simply, there are serious issues around what constitutes cost sharing and how those activities are documented, reported, and used in the construction of the indirect cost proposal.

OMB has decided that MIT and three other major research universities will not be permitted to continue charging the tuition of graduate student research assistants to the employee benefit pool but will be required to treat it as a direct cost to the individual research projects on which they are employed. The implementing regulation, which appears in OMB Circular A-21, provides a transition period which will result in MIT treating tuition as a direct charge for these appointments beginning in fiscal 1999. The problem is compounded now for National Institutes of Health (NIH) awards because that agency is now restricting graduate student compensation (defined as salary plus employee benefits plus tuition charges) to a "reasonable" level and, furthermore, will limit funding from NIH for these costs to \$23,000.

Over the past year, MIT has developed a policy and procedures to implement the disclosure and review requirements of the National Science Foundation (NSF) and the Public Health Service with regard to possible investigator conflict of interest on research projects. NSF and NIH implemented their policies October 1, 1995. Annual updates of disclosures for currently funded awards and pending proposals are now required from all principal investigators. In addition, the Office of Naval Research announced its interim regulations on the same subject in January 1997 and will be developing final regulations this coming year.

INTERNAL INITIATIVES

Significant effort has been devoted toward streamlining some internal processes related to the management of research awards at the Institute which have provided relief to schools, laboratories, and departments, as well as to central administrative offices. We have provided additional flexibility to principal investigators in the use of federal research grant funds by relaxing many of the internal approvals previously required and have streamlined the Research Proposal Summary form, to reduce the items on the form and make the remaining items more useful. In addition, MIT has been accepted into Phase III of the Federal Demonstration Partnership which will provide even greater flexibility to researchers and will provide avenues to utilize electronic initiatives underway by the federal government.

The major internal effort of the office again this year has been in the area of computerization and automation. In addition to full development and implementation of a computerized OSP database to capture award and proposal information, efforts have also been devoted to using this database as the initial feed into the Institute's accounting system for research awards. We have completed the deployment to the Mac environment and are beginning in Summer 1997 full rollout to departments, laboratories, and centers. This will permit more effective and efficient management of awards by OSP staff, will permit Institute personnel to access the database, and will provide the capability to produce standard and custom reports quickly and independently. We are currently in the screen design phase of an electronic proposal system which is targeted for testing in Fall 1997 and implementation in Spring 1998. This will enable any researcher at MIT using the technology already available in the researcher's office or laboratory to electronically create and submit proposals to federal agencies.

COST ANALYSIS

In October 1996 the Office of Cost Analysis was formed and made a part of the Office of Sponsored Programs. A new director was hired and the office acquired a new computerized system for developing the Institute's indirect cost proposal, permitting greater flexibility in projecting costs and developing alternative scenarios for costing. This system will be fully functional in Fall 1997.

CAMPUS RESEARCH VOLUME BY SPONSOR - 1989-1997

(in thousands of dollars)

| <u>FEDERAL</u> | <u>1989</u> | <u>1990</u> | <u>1991</u> | <u>1992</u> | <u>1993</u> | <u>1994</u> | <u>1995</u> | <u>1996</u> | <u>1997</u> |
|--------------------|-------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| DHHS | \$ 52,565 | 57,915 | 59,025 | 60,177 | 64,882 | 60,192 | 61,066 | 58,211 | 57,215 |
| DOE | \$ 54,045 | 61,098 | 60,625 | 57,355 | 57,325 | 63,180 | 67,114 | 69,588 | 70,753 |
| DOD | \$ 47,921 | 51,158 | 49,104 | 48,539 | 66,769 | 61,601 | 55,866 | 59,997 | 67,858 |
| NSF | \$ 38,962 | 38,093 | 37,953 | 36,574 | 38,008 | 39,574 | 38,564 | 35,837 | 36,347 |
| NASA | \$ 15,256 | 18,469 | 22,755 | 25,889 | 32,324 | 37,449 | 41,291 | 39,190 | 36,947 |
| Other | \$ 6,713 | 7,430 | 8,647 | 9,773 | 8,899 | 8,722 | 9,641 | 8,721 | 7,232 |
| Subtotal | \$ 215,462 | 234,163 | 238,109 | 238,307 | 268,206 | 270,718 | 273,542 | 271,544 | 276,352 |
| <u>NON-FEDERAL</u> | | | | | | | | | |
| Industry | \$ 41,937 | 46,223 | 48,360 | 53,578 | 62,068 | 59,117 | 56,120 | 67,164 | 75,194 |
| Nonprofit | \$ 23,602 | 25,220 | 23,751 | 24,920 | 25,593 | 23,666 | 26,430 | 25,926 | 28,952 |
| Other | \$ 4,727 | 5,053 | 5,599 | 5,461 | 5,487 | 6,173 | 5,597 | 5,649 | 7,382 |
| Subtotals | \$ 70,266 | 76,496 | 77,710 | 83,959 | 93,148 | 88,956 | 88,147 | 98,739 | 111,528 |
| TOTAL | \$ 285,728 | 310,660 | 315,819 | 322,267 | 361,354 | 359,674 | 361,689 | 370,283 | 387,880 |

More information about this department can be found on the World Wide Web at the following URL:
<http://web.mit.edu/org/o/osp/www/>

Julie Norris

MIT PRESS

Fiscal 1997 was about building foundations, managing change, adjusting operations, experimenting in electronic delivery, and positioning ourselves strategically to meet challenges of a changing external environment.

Sales of our new list were modestly higher than last year at \$5.6 million. Overall sales in the book division were \$14.4 million, an increase of \$330,000 over last year, short of our forecast of \$14.8 million. While disappointing, we should mention that nationally university press book sales actually declined in the last 6 months of fiscal year 1997. Positive trends include lower manufacturing costs, improving returns rates, subsidiary rights sales exceeding forecasts, significant improvement in scheduling, a 6 percent increase in text sales.

Foreign sales continue robust growth at 7.7 percent overall, with growth in European and Canadian sales leading the pack. While the Press has always enjoyed a higher percentage in gross dollars of foreign sales than any other university press, at 38.4 percent of total sales international markets are increasingly significant to us. Recent enhancements to our international marketing effort include the addition of staff to deal with international booksellers direct from Cambridge and the development of a consortium sales representative in Eastern Europe with six other presses.

The MIT Press made a contribution to RA/TA of \$490,000 which was added to our deferred account to be paid off in succeeding years when RA/TA disappears.

Journal sales increased by 2 percent to \$4.5 million but net results were significantly affected by the cost of startups and shutdowns. We launched two new journals including the *Journal of Industrial Ecology*, and discontinued three journals.

Our Digital Projects Laboratory (DPL) completed work on a new database. Our website now contains vital statistics on 2,778 in print and 1,761 out of print titles. Direct sales online doubled to \$120,000. We expect another doubling next year. Amazon.com sold \$250,000 worth of our books online last year.

It is significant to note that our dependence on bookstores and major bookselling chains such as Barnes & Noble, Borders, and Ingram continues to make us vulnerable in reaching our customers through bookstores. Their buying, stocking, and inventory return policies do not favor the midlist and scholarly books on which university presses make a living. We will continue to find ways to reach our customers with both new and backlist books. Online commerce is certainly a promising avenue and MIT Press is ahead of the pack in this regard.

We have hired a new senior acquisitions editor in the Environmental Sciences and established a new position in acquisition to manage growth and development of our program in finance and management.

Finally we have just completed a move to our new headquarters office at Five Cambridge Center in Kendall Square.

It is significant to note that the top 20, highest grossing titles included books in each of our core disciplines: computer science, economics, architecture/art/aesthetics, cognitive and brain science, philosophy/linguistics, and environmental science.

COMPARATIVE OPERATING RESULTS (IN THOUSANDS)

| | <u>FY97</u> | <u>FY96</u> | <u>FY95</u> |
|-----------------------------|--------------|--------------|--------------|
| Total Net Book Sales | \$14,421 | \$14,09 | \$13,220 |
| Cost of Sales | <u>6,462</u> | <u>6,265</u> | <u>5,751</u> |
| Gross Margin on Sales | 7,959 | 7,826 | 7,469 |
| Other Pub. Income | 204 | 209 | 203 |
| Bookstore Net | <u>100</u> | <u>120</u> | <u>98</u> |
| Total Income | 8,263 | 8,155 | 7,770 |
| Operating Expenses | <u>8,404</u> | <u>8,123</u> | <u>7,893</u> |
| Net Books Division | (142) | 32 | (123) |
| Journals Net | <u>(25)</u> | <u>220</u> | <u>235</u> |
| Net Pub Operations | (167) | 252 | 112 |
| Add: Investment Income- | ----- | ----- | 75 |
| Subtotal: Interest Paid MIT | ----- | ----- | <u>(116)</u> |
| Net Operating Gain (Loss) | <u>167)</u> | <u>252</u> | <u>71</u> |

Faculty serving on The MIT Press Editorial Board in 1996-97 were: Harold Abelson, Julian Beinart, Oliver Blanchard, Josh Cohen, Anita Desai, Deborah Fitzgerald, Bengt Holstrom, Samuel Jay Keyser, Albert Meyer, Greg McRae, William Mitchell and Ron Prinn. Dean Mitchell served as Chair. Frank Urbanowski, Glenn Strehle, and Anne Wolpert served as ex-officio members.

The MIT Press Management Board met twice during the year. Members of the board were: Joseph Esposito, Publishing Consultant; Jack Goellner, former Director of Johns Hopkins University Press; Brewster Kahle, President, Internet Archive; Steven R. Lerman, Professor in the Civil Engineering Department; William J. Mitchell, Dean, School of Architecture and Planning; Richard E. Oldenberg, Chairman, Sotheby's; Dr. Richard Rowe, President RoweCom; Jerome S. Rubin, Group Vice President of Times Mirror; and Jack Schulman, former Director of Cambridge University Press. William Mitchell and Frank Urbanowski serve as ex-officio members of the Management Board; Glenn Strehle serves as chairman of the board.

Sales for this fiscal year overall were not strong, reflecting in part problems in the industry. Sales increased by 2.3 percent for the year, due in large part to very good increases in sales outside the United States, which were 7.7 percent higher than for fiscal 1996. Foreign sales this year accounted for 38.5 percent of our total sales, a substantial increase over last year. Unit sales increased by about 9 percent for the year. Paperback unit sales increased by about 12 percent for the year, and now account for 45 percent of dollar sales.

SUBSIDIARY RIGHTS

The core of our subsidiary rights program is the sale of translation rights to our books. Since fiscal year 1996, income generated by the licensing of foreign rights increased by 18 percent.

Income from our reprint program, which includes permission to photocopy and to publish excerpts from our material, increased by 15 percent in fiscal 1997.

There was a sharp decrease (76 percent) in income from book clubs during fiscal 1997. This is a drop we had predicted since book clubs are operating with increasingly narrow margins. There have been extensive changes in the book club industry in the past year, with emphasis on trade titles.

During fiscal 1997, income from the licensing of electronic rights increased by 5 percent over fiscal 1996.

Overall, subsidiary rights income in fiscal year 1997 increased by 9 percent since fiscal 1996.

MIT PRESS INTERNATIONAL SALES

In fiscal 1997 export sales increased by 7.7 percent over the previous year to over \$5.5 million. Sales to the UK and Europe increased by 13.5 percent and for the first time totaled over \$3 million. Canada rebounded sharply from its doldrums of the previous four years, with sales up over 22 percent. Only Japan among the major export markets showed a significant decline--8.3 percent below fiscal 1996, but was still about 15 percent above fiscal 1994 and 1995 sales. Sales in other export territories were roughly equal to those of last year.

PROMOTION, PUBLICITY AND DIRECT MARKETING

We produced 15 subject area catalogs/brochures, two special promotions, and numerous single book flyers. Our traceable sales through the end of June were \$275,819. Economics continues to be our strongest direct mail subject area with traceable sales for the year of \$71,993. This is followed by Cognitive Science with sales of \$39,098 and Computer Science with sales of \$32,599. Text sales in the U.S. and Canada were \$2,401,276, an increase of almost 6 percent over last year.

The MIT Press exhibited books with our own staffed booth or table at more than 50 U.S. academic conferences in fiscal 1997, and displayed books at over 60 others through combined exhibits. Sales generated from exhibits are currently at \$185,030.

Advertisements for MIT Press books appeared in 500 trade and scholarly journals and magazines, as well as conference programs. All of these ads were produced in-house. The focus of this year's advertising schedule was to implement better target marketing while staying under budget.

The Press's books and authors were covered by a wide array of general and scholarly media this year. Since last July, eight MIT Press titles have been reviewed by *The New York Times Book Review*, and many others have been mentioned in the daily *Times*. MIT Press titles were also covered in such publications as *The Wall Street Journal*, *Los Angeles Times*, *Washington Post*, *USA Today*, *Chicago Tribune*, *Boston Globe*, *Newsweek*, *Business Week*, *Forbes*, *Wired*, *The New Republic*, *Foreign Affairs*, *The Nation*, *The New York Review of Books*, *Scientific American*, *Science News*, *Science*, *Nature*, *New Scientist*, *The Economist*, *The Financial Times*, *The Times Literary Supplement*, and many others, as well as on National Public Radio.

The most widely covered title of the last year was *HAL's Legacy: 2001's Computer as Dream and Reality*, which appeared on a *New York Times* list of university press bestsellers for January of 1997. The book was the subject of reviews and/or feature articles in *USA Today*, *Newsweek*, *Parade*, *The Associated Press*, *The New York Times*, *Chicago Tribune*, *Boston Globe*, and many others. It was the subject of a one-hour discussion on National Public Radio's program "Talk of the Nation: Science Friday," and was additionally covered on NPR's "Weekend Edition."

JOURNALS

In fiscal 1997, the Journals program had gross sales of \$4.5 million, a 2 percent increase over last year. The new journals added in fiscal year 1997 were *European Legacy* and *Journal of Industrial Ecology*. *Design Quarterly* and

Computing Systems discontinued publication. *Thesis Eleven* moved to another publisher at the end of fiscal 1996, and *International Journal of Supercomputer Applications and High Performance Computing* was sold to Sage Science. The division ends the year publishing 35 journals.

Frank Urbanowski

VICE PRESIDENT FOR HUMAN RESOURCES AND EQUAL OPPORTUNITY OFFICER

The following organizations support personnel functions, referred to as the "personnel department," at the Institute: Benefits and Systems; Disability/Accessibility Services; Employee Relations; Human Resources Practices Design/Development; Team Training and Development. Also reporting to the Vice President for Human Resources is MIT's Medical Department. Members of the staffs in the Medical Department, the personnel department, and the associated offices of the Coordinator of Disability/Accessibility Services, and the Family Resource Center, continue to focus energy on finding ways to provide more effective service to the community, to facilitate the process of change, and to seek a better understanding of the unmet needs expressed in feedback from students, faculty and staff.

The Medical Department is to be commended on achieving, for the second time with commendation, accreditation by the Joint Commission on Accreditation of Healthcare Organizations. This achievement is a further recognition of the fine work of members of the department and one of which they can be very proud.

The of Disability/Accessibility Services Office, under the leadership of Barbara Roberts, has experienced an extremely busy year, with a major increase in the number of requests from students for various types of accommodations. The Office has also seen a doubling of requests from employees for help, especially in the area of repetitive strain injuries.

Members of the Benefits Office continue to handle a heavy volume of work. The retirement incentive program provided until September 1996 for faculty and staff to leave MIT. Quite a few members of the faculty and staff took advantage of the additional time to enable a smoother transition in departments. Work needed to be refined and reorganized to ensure that no more than 50% of the administrative, support and service staff positions, vacated as a result of the retirement incentive, were filled. The Personnel Services group worked closely with departments, and with individuals, when the level of stress expressed by employees during the transition period increased as work adjustments were experienced.

The Human Resource Practices Development Team, captained by Patricia Brady, is continuing to work with members of the personnel department, and with the community, to explore and address ways in which work practices can be improved, how certain personnel policies can better reflect employee needs, and to recommend changes in personnel practices that will be more appropriate for our changing work force. The enthusiasm exhibited by the Team is heartening.

I want to take this opportunity to thank all members of the staffs under the Vice President for Human Resources for their dedication, caring, and good humor, and for the help they have given to me and to others during the past year. I want to note especially the work Shelly LaVallee contributed in producing the 1996-97 Affirmative Action Plan.

A number of staffing changes took place. Robert Lewis was promoted to Director of Personnel for Employee Relations, Marianne Howard was promoted to Director of Personnel for Benefits and Systems, Margaret Ann Gray was promoted to Manager of Training and Development, Judy Raymond was promoted to Compensation System Specialist and Toan Mac was promoted to Administrative Staff. Nancy Collins took advantage of the retirement incentive. Deborah Tyrrell, Cynthia Kam and Sarah Conroy left to pursue positions that provided greater interest.

As of June 1, 1997, of the total of 33 administrative staff in the personnel department, 10(30%) are members of minority groups and 23(70%) are women. (In 1996, of the total of 34 administrative staff in the personnel department, 10(29%) were members of minority groups and 27(79%) were women.

As of June 1, 1997, of the total of 20 support staff in the personnel department, 3(16%) are members of minority groups and 15(75%) are women. (In 1996, of the total of 20 support staff in the personnel department, 4(20%) were members of minority groups and 15(75%) were women.

Joan F. Rice

MEDICAL DEPARTMENT

This has been a year of consolidation and retooling in the aftermath of major changes in senior personnel brought on by the early retirement incentive program at MIT. The departure of 17 individuals, 14 in clinically-related activities, was staggered over a period of five months that spanned the prior and current reporting years. At this same time, we were beginning preparations for the visit of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) surveyors in October 1996.

The Department, through the dedicated hard work of individuals at every level, has done extremely well given the challenges we faced internally alongside an ever challenging and competitive outside environment. The JCAHO visit resulted in an overall score of 96% and Accreditation with Commendation for a second consecutive three-year period. Recruitment of key personnel in a number of vital areas has energized and expanded those services. Especially noteworthy has been the new leadership that has been provided by Laureen Gray, R.N., C.S., Director of Nursing, who has greatly enhanced clinical collaboration between physicians and nurse practitioners and improved administrative/clinical joint planning.

Other noteworthy achievements and initiatives that should be mentioned in this introduction include:

1. Combining the Psychiatric and Social Services groups into a single Mental Health Service. In response to complaints from patients about lack of privacy and to facilitate the work of a merged service, we have begun renovations that will be enabling for patients and staff.
2. Continuing improvement in the integration and communication of our patient care activities through an affiliation with Partners HealthCare, especially with services at the MGH in essentially all areas of medicine and surgery, and technologies not available in the Department at MIT.
3. Planning and expansion of medical information system under the very capable leadership of Mr. John Lightfoot and his group along with representatives from clinical and administrative areas.
4. Completion of the first floor renovations during the summer of 1996, providing more comfort, privacy, safety, access and efficiency for patients we serve and our staff. Additionally, a triage nurse is now present in the area to assist patients, who phone in or appear, to get to appropriate clinical providers or services.
5. Redesigning information materials about the Department to improve clarity, emphasize our uniqueness as an MIT institution, focus on new relationships with Partners HealthCare System, and inform and market our health care products to MIT personnel and students
6. Use of focus groups, representing our various constituencies and geographic locations to evaluate the need for alternative satellite locations for receiving care, a piece of our marketing effort.
7. A Department-wide patient service effort, ComMITment to Care, has been launched and a multi-disciplinary steering committee formed as part of our determination to serve our patients and work more effectively among each other.

In concluding this robust introduction, I would be remiss if I failed to emphasize several factors that have contributed to a very significant and productive year. Much of what has been achieved or initiated has been the result of a spirited interdisciplinary effort in which individuals from every level of clinical and administrative responsibility contributed. It has provided a significant momentum that has also been translated into a continuing effort to lower our expenses and improve our revenue. And our commitment to diversity continues as a major goal, realized this past year and currently through the appointment of several providers of Asian background. Without the efforts of the entire Department, but especially with the enormous contributions of Annette Jacobs, Executive Director, and William Kettyle, M.D., Associate Medical Director, this report could not be written with such enthusiasm and pride.

MEDICAL CARE ACTIVITIES

Dental Service

This past year has been one of change and anticipated planning for a combined service with Harvard University's Dental Service. This change has resulted from a combination of factors that included our own planning for the future and discussions with Harvard University's Health Service. As a result, we are looking forward to the future but also have seen changes within the group, namely the retirement of the secretary of many years and the presence of several new dentists. Other than traditional activities of the Dental Service there has been a clinical research effort studying temporal mandibular joint disorder, a common problem seen in dental practices in general and also seen here at MIT.

Medical Service

Several areas within the Medical Services' responsibilities have been addressed during this past year. With the early retirement initiative we were given the opportunity to re-examine the Trauma/Triage area and also the Urgent Care appointments' scheduling. Working with the nursing service, a nurse practitioner for this area was hired and, in addition, a second nurse with competence as a triage provider was added. Both moves have represented an improvement in our ability to serve patients. In addition, we also have instituted nursing coverage for immunizations and certain other routine procedures. Finally, in February, the Department welcomed a new internist, an accomplished infectious disease and general physician, Howard Heller, who had served at the Massachusetts General Hospital for the past six years.

The relationships with the MGH have continued to evolve. Our internists now cover and care for hospitalized patients at the MGH when admitted to the general medical service and we continue to benefit by having a tertiary cardiologist, Dr. James McFarland, provide care for patients with acute cardiology problems. Direct access to MGH patient computerized data has been achieved and is now directly available in physicians' offices here at MIT.

A program to evaluate internists' contributions to the clinical and extra clinical work of the Department was introduced by Dr. William Kettle, Associate Medical Director. Many areas are included in this evaluative instrument which also provides a program for monitoring activities on the clinical care service. Our internists are now HMO Blue providers and this will enable the Department to negotiate better rates with outside hospitals. We are also in preparation for a Senior Plan which we hope to have in place this next year which will allow us to receive Medicare reimbursement for patients who are hospitalized in our Inpatient Unit.

In addition to these activities, as well as ongoing patient care activities, the majority of internists and nurse practitioners participated in an Advanced Cardiac Life Support course that was given for the MIT and Harvard University Health Services and hosted here at MIT. Other educational activities continued as before with weekly primary care conferences, attended by both physicians and nurse practitioners, as well as at least a monthly educational luncheon conference.

In summary, despite a number of changes and transitions in the Medical Department, the internists continued to strive to deliver high quality personalized health care while being ever mindful of the need for efficiencies and cost reductions in caring maximally for our patients.

After Hours Service

Emergency and urgent care services are provided on a 24-hour basis in the After Hours Service, now staffed by a roster of department physicians, nurse practitioners, and a group of part-time internists and pediatricians from the major teaching hospitals in the greater Boston area. Over the past year, the volume has stabilized, but patient waits have been significantly reduced by introducing a same-day appointment system and by focusing staff during peak patient hours. Focused quality assurance reviews of common medical problems seen in the service, updating of equipment and medications, re-educating staff in emergency procedures including advanced cardiac life support, all continue as efforts to improve the standard of care we offer our patients. In the late spring of this year, Dr. Howard Heller began a transition to take over the duties of the After Hours Service which will be eventually relinquished by Dr. Firm at the beginning of July 1997.

Inpatient Medical Service

The Inpatient Unit continues to play a vital role in the care and management of MIT patients. There were 789 admissions encompassing 2560 patient days this year and included students, dependents, affiliates, health plan members, Medicare recipients and a number of others who were here on a fee-for-service basis. Efforts are continuing to designate the Inpatient Unit as a Part A Medicare provider and we are quite hopeful that this will be realized in the upcoming year.

The Clinical Research Center had 414 inpatient days and we are currently working with the CRC to find alternative methods so that funding for inpatient research can be increased beyond its current level. Renovations are planned for July of 1997 in two inpatient rooms that will facilitate sleep study research which is an ongoing activity in the Clinical Research Center.

Obstetrics and Gynecology Service

The statistics for this past year were essentially unchanged from the prior report with approximately 7500 patient visits, 166 deliveries, a very low Caesarian section rate of 12% for primary and 3% for repeat, and GYN surgeries that were slightly increased to 57 from 52 the prior year.

The major staff changes this year were the retirement of our certified nurse midwife Barbara Merrifield and the imminent resignation of Dr. James Marquardt who served as a full-time physician on the service for one year. We have identified an obstetrician to join the service in August, 1997, and our primary care nurse practitioner, Dolores Vidal, has taken on a larger responsibility to fill in for the departed individuals. Our full-time physicians continue to have full admitting privileges at both the MGH and Brigham and Women's Hospital and this eases continuity of care on those occasion when patients are admitted to the MGH rather than to our primary OB/Gyn, Brigham and Women's Hospital.

Of interest has been regularly scheduled meetings with Dr. David Acker, Chief of the Brigham's Obstetrical Service. The hospital Caesarian rate is in the low 20% percentile and our service consistently has one of the lowest rates at the hospital and this is especially true because of our low percentage of repeat Caesarian sections with many patients having the ability to add a trial of labor with 90+% being successful for a second pregnancy. All of our practitioners continue to participate in community activities including IAP lectures, premedical advising, MEDLinks advising and the HST program introducing first year HST students to clinical medicine. The group also mentors Harvard Medical School primary care residents and supervises residents at the Brigham and Women's Gyn clinic.

Pediatrics

Administratively the Pediatric Service has been effectively reorganized thanks to a major effort of our nurse practitioner coordinator, Pat Bartels. The streamlining of the service has allowed for greater efficiencies and also the ability to take on Harvard Medical students in a primary care pediatric practice rotation. In addition, the MGH has selected our Pediatric Service as a continuity clinic for its residents.

Several research projects were initiated during this year that will benefit the entire MIT community, but especially the student sector. One project is studying the epidemiology of whooping cough (pertussis) to determine whether one antibiotic treatment or an alternative is more appropriate in this population. The second project is examining the epidemiology of acute and persistent cough problems in the community and has been initiated because of the upswing of cases of whooping cough that ordinarily have been thought of as being due to some other pathogen in individuals who have a record of prior immunization. Another area that we are looking at relates to cross cultural issues that stand in the way of students' recognizing mental health symptoms in themselves and at the same time to examine more broadly barriers that the students perceive in seeking services of the Mental Health group at MIT.

During the year we have had a number of meetings of the Student Medical Advisory Council and through the council it has been made clear that communication between the Medical Department and the student body was not optimally effective especially as regards services that are available. As a result, there has been a significant revision, with student input, into the program materials that are provided for students who have already matriculated or are matriculating at MIT.

Psychiatry Service

At the same time that the Psychiatric and Social Work services have been joined to form the Mental Health Service of the Department, we had to sadly say farewell to two outstanding social workers, Maria Rodriguez, M.S.W., and Jackie Buck, M.S.W., both of whom took the early retirement after many years of productive service.

The retirement of three members of the Psychiatric Service and the departure of our child psychiatrist has been followed by some changes that should add back considerable strength to the Service. Kristine Cha, M.D., a graduate of MIT and a child and adult psychiatrist has been recruited to take over responsibilities in both areas and, in addition, Dr. Lili Gottfried with Dr. Cha have become full-time members of the Mental Health Service.

Utilization of Psychiatry and Social Work services remained essentially unchanged as compared to the preceding years. Hospitalization days declined somewhat, and length of stay fell dramatically in response to the pressures of managed care as well as better management within our own service. We are welcoming a new group of trainees in Psychiatry and Psychology for the upcoming year. Members of the Mental Health Service continue to be very active in community services on an individual basis as well as in courses delivered at IAP. Dr. Margaret Ross has provided significant input into the work of the Health Education Service.

Social Work

Planning has been completed during the past year to merge the social work service with the psychiatric service.

Surgical Services

The Surgical Services have undergone a significant change this past year with the retirement of Dr. Healey and the affiliation of the Department with the MGH. We have developed a new relationship with the General Surgical Services including the participation here at MIT of two senior surgeons, Ashby Moncure, M.D., and Carlos Fernandez, M.D. These individuals along with their general surgical group and Dr. Geoghegan provide night and weekend coverage on a rotation basis. All general surgery, inpatient and day cases, are now performed at the MGH with the exception of those patients who have had previous relationships at other institutions. We are currently working in a multi-disciplinary group to review and improve the services that we provide for patients with complex problems such as breast cancer.

Nursing Service

The Nursing Service continues to provide clinical care through its nurse practitioners, physician assistants, and registered nurses throughout the Medical Department and at Lincoln Laboratory. A new nursing role was recently added to the Department, namely a triage nurse functioning to facilitate timely and appropriate care for the patient population that requires health information via phone or links between patients and MIT Medical services. Community service continues to be a major focus of the nursing group and this included coordinating and screening several hundred patients in the dorms following a case of tuberculosis on the campus in the fall of 1996. Several of the nurse practitioners precepted graduate nursing students for advanced practice from the MGH Institute of Health Professions and Simmons College. Nursing continuing education committee organized three successful educational events on a variety of clinical and professional topics during this past year. An effort is under way to build a collaborative practice between physician and nursing groups where the skills and expertise of each discipline can come together to improve patient care.

OTHER ACTIVITIES

Clinical Research Center

The CRC NIH grant is in the second of four years of funding at the end of which cycle we will have been supported for a total of 37 years. Studies done at the CRC continue to focus on human nutrition and metabolism, neuroscience and brain function. The CRC continues to relate clinically to the Medical Department and houses inpatients in the Medical Department Inpatient Unit. Representatives from the CRC serve on all of the major committees of the Medical Department including the Medical Executive Committee. The CRC is currently examining its relationships with other CRCs in the greater Boston area including Beth Israel Deaconess and the Massachusetts General Hospital.

Environmental Medical Service

The Environmental Medical Service related intimately in its patient care activities to the Medical Department where

clinical evaluations, medical surveillance for exposures, and anticipation of various environmental hazards are undertaken. The Chief of the Service also has an appointment through Massachusetts General Hospital's Pulmonary Service where consultations on occupational lung disease and other occupational ailments are reviewed. In addition to the direct relationships to the Medical Department, EMS administratively is overseeing a group of 50 professionals serving in various occupational environmental health disciplines that include biological safety, industrial hygiene, and radiation protection. Our educational efforts have included participation in IAP activities, lectures on campus including the Sloan School of Management, and to administrative offices and personnel at the Lincoln Laboratory. Training of occupational medical residents from local programs has also been overseen and has led to a number of publishable papers on projects done at MIT.

Our industrial hygiene group, led by Lou DeBernardinis, Industrial Hygiene Officer, had a number of accomplishments during this past year which have included close to 3,000 laboratory analyses, several applied research projects concerning areas such as laboratory chemical hood characteristics, as well as exposure assessment of laboratory personnel. The group has participated in academic courses in the Chemical and Mechanical Engineering Departments and has worked with the audit division to be sure of the Institute's compliance with OSHA laboratory standards. Finally improved communication with the MIT community has included a Web page to provide information and resource guides, and also training to over 1,000 Institute personnel on subjects which have included ergonomics, asbestos, noise and hazardous materials.

The Biosafety Office, ably led by Claudia Mickelson, Biological Safety Officer, continues to offer training and education to a large number of MIT groups each year. They continue to assist the formation of departmental safety committees including the physical plant safety learning and performance committee which was formed this past year. The Biosafety Office trains over 1,000 MIT employees annually up from 750 the year before. Membership on the Institute Animal Care and Use Committee has been an important factor leading to animal research biosafety standards as well as the inspection of the animal research laboratories and facilities at MIT. The laboratory is participating in the AIHA certification program for environmental microbiology laboratories and most members of the Biosafety Office serve on varied professional committees both at MIT and outside. Education and research are two other areas that are actively pursued to the benefit of the Biosafety group as well as MIT and its affiliated institutions.

The report from Frank Massé, Radiation Protection Officer, involves a review of the divisions on campus, the Bates Lab, and Reactor. All of these maintain training, personnel monitoring, radiation survey, radioactive waste management, record keeping, authorization review, radiation committee support and emergency response programs throughout the year.

Health Education Service

The Health Education Service has expanded in many areas during the past year including the collection of reference books, videos, and brochures that reflect the growing demand of the MIT community. With guidance from the Health Education Advisory Group and the Medical Department administration, special emphasis was placed on selected areas including preventive medicine (wellness), diabetes, and cancer. Fall and spring health promotion programs led tirelessly by Sally Ciampa have focused on nutrition, exercise, and stress management techniques. The anonymous evaluation forms distributed to all workshop participants this year were returned with a 99.9% positive review, with the dissatisfaction rating due to cold weather.

Annual IAP Medical Department calendar showed 81 sessions, an all-time record high, with a focus on information for those in the community affected by diabetes and highlighted with a diabetes open house that attracted significant attention. All programs received high marks. In addition to campus activities, Health Education contributed substantially to the Draper Lab Benefits Fair and International Open House at MIT.

Efforts in Health Education for students continued under the dedicated leadership of Tracy Desovich focusing on community development and strategies for education. The MEDLinks program allowed 60 new individuals to complete at least one 20-hour training session, continuing education was offered each month to the entire group of 120 MEDLinks students on topics which included date rape, pertussis, stress management, fitness and nutrition. As peer advocates in the living groups, MEDLinks facilitated expanded programs and activities which included 200 personal contacts with students and over 700 students in health education workshops. Campus wide events were

held to increase community awareness in World AIDS Day, in Keeping Intimacy Safe and Sensual, and the Spring Health Expo.

A Staying Healthy resource binder was developed, covering nine topics central to student health. These binders, sponsored by the Dean's office, were given to Housemasters, graduate resident tutors, MEDLinks, and several medical department providers. Successful coordination and cooperation with many ongoing working groups on campus have continued enriching student health initiatives and the MIT student community in mutually beneficial ways.

Finally, a health education prescription pad designed and distributed to all providers in the Department has led to better communication between providers and patients. Along with newly renovated and brightened space, the Service has become more attractive and useful to members of the community and our visibility has also been increased with regular written sessions in *health@mit* and *MIT MED News*.

Lincoln Laboratory Medical Service

The Clinic continues to play an active role in the care of Lincoln Laboratory employees, visitors, students, subcontractors, and special program participants. The Clinic serves a vital function directly and also through its ability to solve or triage major and minor medical and surgical problems. The Clinic also supports the Department by offering phlebotomy for laboratory tests, prescription delivery service for MIT Health Plan members, and performance of electrocardiograms which can be faxed along with other pertinent clinic information to the MIT primary care provider. A planned effort at re-initiating educational programs for Lincoln Laboratory population is under way.

Clinical Operations and Administration

Implementation of the affiliation with the Partners HealthCare Network continues to be a major administrative project. Although the transitions required by this affiliation have forced us to sever long-standing relationships, the process is going smoothly and our new association with the staff and services of the Massachusetts General Hospital has been both rewarding and exciting. The transitions have also allowed us to rethink and revise the procurement of professional and hospital based services for our patients. Maintaining and even improving quality, while at the same time decreasing cost have been the outcome of several new arrangements fostered by our Partners affiliation.

New contractual arrangements that will enhance our Dermatology, Orthopedic and Urology Services have been negotiated and will go into effect during the 1997-1998 year. New technologies have been added in the laboratory (automated blood cell counter and coagulation evaluation systems) and in the surgical subspecialties (flexible, fiberoptic cystoscope) that will improve our clinical care system within the Medical Department.

To improve patient access to care and to make maximal use of our physical plant, an evening hours program has been implemented. Staying open until 8 pm on Tuesday evening with both scheduled appointments and nearly all ancillary clinical services available has been popular with our patients. A total of 1,524 patients were seen during these evening hours for the period July 1, 1996 through June 30, 1997.

In addition to the JCAHO (Joint Commission on Accreditation of Healthcare Organizations) accreditation with commendation received during the year, both the laboratory and the mammography services of the Medical Department received certification or accreditation by the appropriate surveying agency.

The information system group at the Medical Department, together with a group of clinicians and administrators, is working to identify a software system that will facilitate clinical operations and provide both improved patient care and better information with which to make administrative decisions.

MIT Health Plans

The MIT Health Plans, for the first time in years, saw the total membership fall slightly below 50% of the total MIT employee base in the Traditional and Flexible plans. Even though the overall employee base at MIT is smaller, it is imperative that the Health Plans strive to retain current members and gain new members to ensure their long term viability.

Newly published marketing materials emphasize the unique aspects of both plans; focus groups and a telephone survey of members and non-members gathered information on many issues of concern regarding location, premiums, benefits currently offered and benefits members would like to see offered.

In response to requests, the Health Plans is in the development phase of a senior plan affiliated with one of the local senior plans. The Health Plans staff is working with a consulting actuary on the financial aspects of a senior plan, as cuts in the Medicare program present new questions about the Department's assuming this type of financial risk. The Health Plans will present this new venture to the Medical Management Board in the fall.

Last fall, the Health Plans managers successfully negotiated very favorable rates for outside services with BlueCross-BlueShield. However, continued cost pressures for outside services, demand for competitive premiums and enhanced benefits for our members will once again challenge the management team during this year's open enrollment period.

Administrative Operations and Management

Many of the activities that have been undertaken in the past year are interdisciplinary. We are working diligently to continue to improve our services as exemplified by the JCAHO accreditation with commendation and an initiative, ComMITment to Care, which we consider a major department activity.

In addition to a great deal of time spent early in the year in preparation for the JCAHO visit, the affiliation with Partners entered its second year and for the most part the relationship is running very smoothly. We continue to look for ways to reduce costs and increase revenues and are evaluating a number of areas to see if by reassignment of staff and flexible scheduling we can meet patient needs at lower expense.

Recruitment and training of new staff have been a major focus, part of an ongoing effort to improve people's understandings of their jobs and ensuring that good communication is occurring between managers and staff. In that spirit, we have rewritten all of the job descriptions in the administrative area into a performance based format which is now the basis for employee evaluation. We have also formed a number of interdisciplinary, administrative and clinical staff committees within the Department and are working to address issues to improve our services.

We are investigating the possibility of a satellite facility in one of the areas where some interest has been shown by ongoing market research. The bottom line of all our efforts is to provide low barrier, quality care to all of our patients, enhance our bottom line through efforts at cost containment, and recruiting individuals to become members of our health plan.

CONCLUSION

The Medical Department experienced a busy year of consolidation -- strengthening relationships with our Partners affiliation, concluding a highly successful survey by the JCAHO, and integrating new hires in positions of leadership and in basic areas while maintaining quality and low barrier care. True to our principles, we continue to serve the MIT community in many ways beyond traditional medical care as health educators, advisors for faculty and administration, pre-medical student advisors, contributors to formal and IAP courses, service on various committees of the Institute, and providing a range of interventions in individual and family personal matters through our employee benefit and mental health services. A major ongoing priority, best described as interdisciplinary and committed, is to improve our fiscal situation through greater efficiencies as we market a health product that we consider outstanding.

Arnold N. Weinberg, M.D.

TRAINING AND DEVELOPMENT

The Training & Development Programs office in Personnel sponsored courses offered to all MIT employees as well as specific courses tailored for departments, laboratories, and centers. Over 1200 people attended these programs. There were a variety of topics to provide knowledge and skills for employees to use in the workplace. These topics included negotiations and conflict, team building, resilience during change, communications, interviewing, and

leadership. Most courses in the fall generated waiting lists, so these courses were repeated during the spring semester.

The office continued the support of the performance appraisal training begun last year. The course in how to give performance appraisals was offered quarterly and the one in how to receive them was offered monthly. New employees were encouraged to attend by their management. In addition, a course on team performance appraisals was developed, piloted, revised and taught to several work teams.

In support of the major changes taking place at MIT, the Training & Development Planning Team served as internal consultants and worked within a variety of areas to provide expertise about the training needs resulting from redesigns. Such areas included Student Services, Information Systems, and the Publishing Services Bureau. The team began to define their roles to become performance consultants as well as trainers. This step helps to make training an investment with measurable results.

In addition, Margaret Ann Gray served as a member of the Human Resources Practices Development Team. (See the separate report about this team and its work.)

Margaret Ann Gray

DISABILITY/ACCESSIBILITY SERVICES

The Disabilities Services Office (DSO) is responsible for providing effective disability services and programs for students, faculty, and employees at MIT. These services include physical and communication access, academic accommodations for students, and the identification and implementation of reasonable accommodations for employees.

Over the past year, 13 different presentations were delivered to the MIT community on their responsibilities during the hiring process to ensure that persons with disabilities are a) provided necessary accommodations when seeking employment; b) are treated consistently and fairly; and c) that position descriptions do not impermissibly screen-out persons with disabilities. Work has continued with individual departments developing procedures for rewriting job descriptions to properly identify essential job functions.

Disabilities Services works with the personnel officers, departments heads, immediate supervisors, and outside agencies to provide employees with disabilities an interactive process in identifying appropriate reasonable accommodations. A total of 35 employees, including 4 Lincoln Laboratory employees, identified themselves as individuals with disabilities and requested accommodations.

In addition to providing academic access to students with disabilities in the form of course material translation, the DSO has focused on the creation of administrative forms and a set of Institute policies and procedures to provide accurate guidelines for students and faculty requesting/receiving services.

With input from numerous people in the MIT community and with the approval of the Faculty Council, the DSO has developed a guideline titled "Policies and Procedures For MIT Students with Disabilities." This guide outlines MIT's commitment to individuals with disabilities and the philosophy of the DSO. It clearly defines the processes used by our office for requesting and obtaining reasonable accommodations in order to balance the student's right to access with our obligation to protect the integrity of the Institute programs and services.

In developing this policy, it has unified the entities providing academic access at MIT by defining a more efficient and consistent system for obtaining services. These entities would include the DSO, Adaptive Technology for Information and Computing (ATIC) Lab, the Learning Disabilities Specialist, and the Office of Undergraduate Academic Affairs.

Barbara Roberts

HUMAN RESOURCE PRACTICES DESIGN/DEVELOPMENT TEAM

The HPRD team, sponsored by the Vice President for Human Resources, was convened in June 1996 to evaluate current human resource practices at the Institute and to recommend changes to support the changing needs of the Institute. The Human Resource Principles adopted in 1994 provided the foundation for the team's work.

Members of the design team from June through October 1996 were: Patricia Brady (Center for Real Estate), Team Leader; Richard Brewer (Undergraduate Education and Student Affairs); Jennifer Combs (Physical Plant); Margaret Ann Gray (Personnel); Alyce Johnson (Personnel); Anne Maynard (Dept of Aeronautics and Astronautics); Peter Narbonne (Financial Aid Office); Jeff Pankin (Information Systems); Barbara Peacock-Coady (Leaders for Manufacturing); and Tia Tilson (Resource Development).

The human resource practices within the scope of the design study were career pathing, career planning, classification, compensation /recognition /other rewards, hiring, individual and team development, job design, planning and appraisal, and succession planning.

The design study methodology included data-gathering across campus (through interviews, focus groups, and community-wide events involving 10% of the campus); benchmarking with other universities and research-focused companies; and classroom instruction and learning for team members.

In the draft design study presented to the Reengineering Steering Committee in October 1996, the team made broad recommendations for changes in the areas of classification; compensation; rewards and recognition; hiring and transfer processes; performance planning and assessment; training and development; career development; and strategic planning.

Additional comments and suggestions from the Academic Council and the five school councils helped to better define and clarify the draft recommendations and set the stage set for work to begin with departments, labs and centers to test and evaluate new or revised practices.

Five members of the design team (Brady, Gray, Johnson, Narbonne and Peacock-Coady) reconvened and with the addition of Melissa Damon (Project Administrator) and Steven Wade Neiterman (Information Systems), began work as the development team in February 1997. Also joining the project in March as the liaison for implementation of new practices was Cynthia Vallino (Personnel).

The next phase of the ongoing development of human resource practices will focus on classification and compensation; recognition and rewards; training and development; generic roles and competencies; and performance planning and assessment.

Patricia A. Brady

EMPLOYEE RELATIONS

Employee Relations consists of three areas within the personnel department: Personnel Services, Labor Relations, and Compensation.

PERSONNEL SERVICES

The primary mission of the Personnel Services section is to provide a full range of employee relations services to both employees and supervisors within the various organizational units. These include staffing assistance, job counseling, policy interpretation, performance evaluation, salary administration and conflict resolution. This group consists of seven Personnel Officers and two full-time and one half-time staff assistant. Additionally, we received authorization to hire two Personnel Generalists to give us greater flexibility in providing assistance in re-engineering projects.

During the year we continued to work closely with several of the reengineering teams advising them on the human resource implications of planned redesigns. Two Personnel Officers were assigned to reengineering teams on more or less a full-time basis, Alyce Johnson to the Human Resources Practices Design Team and Maureen Wolfe to the

Student Services Reengineering Team. We were also actively involved in counseling employees affected by the closing of Graphic Arts and the Design Services Office, as well as the spin off of the Office of Facilities Management Systems as a separate entity from MIT. We continued our efforts to expand and improve the practice of giving and receiving performance evaluations with several Personnel Officers involved in ongoing training. We revised the Institute's policy statement on the Family and Medical Leave Act (FMLA), which continues to be a complicated law to administer in conjunction with existing MIT leave and benefit provisions. We improved our applicant tracking system so that all resumes and applications are scanned into our database, and have set up a computer in our reception area with direct access to several job search web sites to assist employees with their job searches.

We also represented the Institute before the Massachusetts Commission Against Discrimination and the Cambridge Human Rights Commission. During the fiscal year, 8 claims were filed with these agencies and to date, neither Commission has found probable cause in any of these cases.

Personnel Services also provides support in the processing of job listings, applicant materials, employment advertising, and unemployment claims for Campus employees. The group is also responsible for the reception area activities for the Campus Personnel Office.

During the past year approximately 11,000 applications for positions were received and processed, 734 persons were hired for positions listed in the Personnel Office, of whom 117 were MIT internal applicants who were seeking employment alternatives for either promotional opportunities or other reasons. Kenneth Wolff, Employment Officer, reviewed 1,430 applications for support staff positions, interviewed 120 candidates and assisted in filling 180 positions.

Personnel Services was also very much involved in the upgrading of the applicant tracking software, Restrac. Some of the features of this system are: resume scanning, tracking applicant activity and searching the resume database to match skilled candidates to open positions.

Some 185 unemployment claims were processed this year for former Campus employees. We work closely with the representatives of the Massachusetts Department of Employment and Training to provide timely information to employees who terminate and may be eligible for benefits, including individuals in departments impacted by funding or staff restructuring related to re-engineering efforts. We continue to partner with Manchester Partners International to provide employees with outplacement and career counseling assistance.

LABOR RELATIONS

The Office of Labor Relations is responsible for negotiating and administering the collective bargaining agreements covering approximately 1,400 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 July 10, 1996, the Institute signed a new agreement with the Security Officers' Independent Union (SOIU), the Union that represents the security guards at Lincoln Laboratory. The wage increases in the agreement are consistent with MIT budgetary guidelines.

Four Agreements expire on June 30, 1997: the Agreements with the Service Employees' International Union, Local 254 (for two bargaining units, Campus and Lincoln Laboratory/Haystack Observatory; the Research, Development and Technical Employees' Union (RDTEU); and the MIT Campus Police Association. Negotiations for successor agreements continue as of the date of writing.

The number of grievances fell in comparison with the previous year, though the decline was less steep than the decline from 1995 to 1996. Four Arbitration cases were settled prior to arbitration. One case will require additional days of hearing before testimony is complete. Five grievances have been filed to arbitration and have yet to be heard.

During the year, the Office of Labor Relations also handled six cases brought before the National Labor Relations Board. Of these, two cases were resolved in favor of MIT, one was settled prior to going to the Complaint stage and three were deferred to arbitration.

In addition, this Office provided advice and counsel to departments, centers, and laboratories contemplating business design changes that impact on collective bargaining issues, and continued to work closely in support of various reengineering efforts.

COMPENSATION

The mission of the Compensation Office is to establish and implement fair, equitable and competitive compensation programs for the Institute's faculty, research, administrative and support staff, in accordance with the Institute's reward philosophy and strategy.

This year, the Compensation Office participated in 37 external salary surveys conducted by universities, associations, and consulting groups from across the country. As in previous years, the Office conducted two major surveys with approximately 30 participants each. The survey results continue to provide us with a solid basis for determining our market position, and in developing our review allocation proposal to the Executive Committee.

Nine salary reviews covering approximately 6,600 Campus employees were conducted this year. As part of our continuous effort to increase the efficiency and effectiveness of the annual salary review processes, we continue to use electronic review sheets for the faculty review which were used by the Dean's Offices; and for the research, administrative and support staff review, electronic review sheets were provided to the Personnel Officers. All of the electronic review sheets provide meaningful summary statistics which enable management to assess the financial impact of review recommendations. The feedback from users continues to be most favorable.

A total of 122 administrative positions were classified or re-classified this fiscal year. This is higher than in the recent past mostly due to the reengineering efforts and reorganizations that have been taking place at the Institute. The process to request classification of new or existing positions can now be done electronically, which not only reduces the amount of paper flow, but more significantly, reduces the duplication of effort and time needed to record job descriptions. The classification of new or existing positions is currently done by the Personnel Officers using an electronic template. They then bring the classification request before a classification review committee for discussion and review. This new process has received favorable feedback from the Personnel Officers and their departments. In addition, we use an electronic job description index, which provides quick and easy access to the library of over 1,000 job descriptions which currently exist in our electronic system.

PERSONNEL CHANGES

During this period, Cynthia Kam, Manager of Compensation, resigned. A serious search for her replacement is on going. William Cain and Lianne Shields were hired and Maureen Wolfe rehired as Personnel Officers. Mary Files, Administrative Assistant, transferred into the office from Physical Plant. We were successful in meeting our Affirmative Action goals for women, with women comprising 65% of the Employee Relations group. We need to improve our efforts at diversifying our group as presently 15% of the group is represented by members of minority groups.

Robert J. Lewis

BENEFITS AND SYSTEMS

The Personnel Office was reorganized in November 1996. The Benefits Office, Faculty and Staff Information Services (FASIS) and the Family Resource Center were realigned under the supervision of the Director of Personnel for Benefits and Systems.

FACULTY AND STAFF INFORMATION SERVICES

Faculty and Staff Information Services (FASIS) has the responsibility to acquire, maintain, and provide employment information about faculty, staff and other persons affiliated with MIT and to ensure the currency, privacy, and accuracy of this information. In addition this office serves as the department liaison with computer support groups in the development of long-range personnel computer systems.

The Office continues to process approximately 14,000 transactions for appointments and changes. In addition, the office continues its role in the processing of salary reviews, in the servicing of data requests received from within the Personnel Office and the MIT Community, in responding to external employment verification requests, and in the production of the staff telephone directory.

There are two main computer systems in the Personnel Office. The Cyborg Human Resource System and the Restrac Employment Management System. Both systems were upgraded this fiscal year. The Cyborg system was upgraded to Cyborg/Oracle in the test environment. Steps have been taken to upgrade Cyborg/Oracle in production. This upgrade will be completed in the next fiscal year. The Restrac system had several major upgrades. Restrac was first upgraded to the Oracle/Novell platform. The second major upgrade was the migration of Restrac from Oracle/Novell to Oracle/Unix. This included the purchase and installation of a DEC Alpha Server. Finally, Restrac was upgraded from version 2.0 to its current version of 3.1.1. The new version has many features that will simplify the resume tracking process and requires less customization. These new features will be made available in the upcoming fiscal year.

Other upgrades included P. C. upgrades to pentium processors and software upgrades to windows 95, windows NT, and Microsoft Office.

This fiscal year data and process enhancements included the development of an automated electronic feed of home-address updates to Payroll and the development of electronic feeds to the health carriers. In addition numerous data files and listings were generated to support the data needs of the Personnel Office.

This fiscal year we have begun to design web pages for the Vice President for Human Resource. We will continue to gather information that is pertinent for this website.

We continue to work closely with Information Systems to improve the *The Query Facility* application. This application was modified and deployed to several departments.

Claire Paulding

BENEFITS ADMINISTRATION

During the past year, the Benefits Office conducted a review of its internal administrative procedures which resulted in improved communication with employees and more efficient work flows. In addition, the staff has focused on its own training, cross-training and development by participating in a series of updates covering government compliance, administrative issues and recent legislation affecting employee benefits.

A new third party administrator was selected for the Long Term Disability Plan following a review of plan objectives. Proposals were requested of several vendors prior to awarding the contract. The Benefits Office has worked closely with Personnel Officers, the Disability Services Office and the Safety Office in a continuing effort to develop an integrated approach to disability management.

In response to a decision by Blue Cross and Blue Shield to discontinue Bay State Health Care Plan, the Benefits Office reviewed the Institute's health plan options and recommended a new Blue Cross product called Blue Choice to replace Bay State and the Blue Cross Option II Plan. The Benefits Office communicated directly with members of both plans in advance of the annual open enrollment period to allow them ample time to review their health care needs. Several informational meetings were held that allowed plan members opportunities to speak with Blue Cross and Blue Shield representatives.

During three weeks in late November and early December, approximately 2,000 employees made over 3,000 changes to their benefits using the BenChoice telephone enrollment system. Employees used the phone system to make 1,000 changes in health coverage and 1,300 individuals elected to save taxes on medical and dependent care expenses in 1997 by enrolling in FRAP. More than 200 employees took advantage of tax-deferred retirement savings opportunities by increasing their contributions to the Supplemental 401(k) Plan. Use of this telephone enrollment system helped the Benefits Office to provide improved service by dramatically decreasing the amount of

staff time devoted to processing benefit changes and increasing the time available for the Benefits Office staff to counsel employees about the various options available to them.

The Benefits Office expanded its efforts at providing retirement planning and investment education services by sponsoring or co-sponsoring 6 series of seminars and workshops on investment fundamentals, estate planning issues, and retirement lifestyle concerns. These were attended by more than 1,400 employees and retirees.

The Benefits Office completed the counseling and collection of benefits elections associated with the Special Retirement Incentive Program. In addition, we continued our efforts at reengineering our operations by simplifying processes, and by adapting Special Retirement Incentive Program automated processes for ongoing, routine use.

We began a comprehensive review of MIT Retirement Plan operation and provisions in an attempt to simplify the plan, increase member understanding of their benefits and options, improve service delivery, and decrease plan expenses. This review will continue through 1997-98.

We are currently in the implementation phase of a project to send benefits enrollment data electronically to our health and dental carriers. This project will result in savings for MIT and streamline the enrollment process for employees.

The Benefits Office web site has undergone further development including information on current benefits provisions, benefit related events, such as the IAP retirement presentations and open enrollments.

This year the Benefits Office provided data to the Strategic Review of Benefits committee for use in the evaluation of the MIT benefit programs.

The Benefits Office and FASIS currently are working together to develop a self-service application to allow employees to make their benefit elections using either the phone or the web. Future uses of this application will allow employees to update their personal information on the personnel system.

During the year, Scott Runkle joined the Benefits Office. He had previously worked as a Retirement Counselor during the Special Early Retirement Program. Toan Mac was promoted to Administrative Staff.

Marianne Howard

FAMILY RESOURCE CENTER

The Family Resource Center offers faculty, staff and students a broad range of services to assist with child care and schooling, normal parenting concerns, family relocation, and balancing work and family. In addition, the Center participates in a number of institutional, local and national work/life initiatives and makes available information and research on these issues.

This year, services offered by the Center included approximately 1200 office consultations, plus 25 informational "briefings", 30 workshops, and 4 ongoing discussions groups; approximately 600 members of the MIT community attended workshops and groups.

As an internal resource on work/life issues, Center activities this year included contributions to supervisor training efforts and discussions of faculty leave policies. Externally, once again the Center played a leadership role in national professional organizations, including the creation of a professional organization for the field of parenting education, called the National Parenting Education Network.

Adding to efforts to publicize services within the MIT community, the Family Resource Center's new web page now provides an on-line overview of Center offerings plus resource information and a calendar of Center-sponsored events.

This year too, the Family Resource Center received national recognition as a model university-based work/life program, contributing to MIT's placement within the nation's top-ranking "family-supportive" campuses, based on the results of a national study conducted by the Families and Work Institute and the College and University Personnel Association.

With respect to physical facilities, planning has continued on the design of the Center's new, significantly enlarged space in Building 16, with the move scheduled for the spring of 1998.

The Center has actively sought to achieve minority representation on its staff of three. Although unable to implement any plans with respect to staff hiring this year because there were no openings, we have actively worked to strengthen our resources to support minority recruitment and employment at the Institute.

In a new development this year, the Center co-administrators now report to Marianne Howard, Director of Personnel Benefits and Systems.

Kathy Simons, A. Rae Simpson

VICE PRESIDENT FOR INFORMATION SYSTEMS

Information Systems (IS) strives to enable members of the MIT community to use information technology more productively in all their work. IS focuses on four strategic objectives: to align IS with Institute needs by ensuring that MIT processes use modern information technology (I/T) effectively; to grow IS's reputation for customer service and operational excellence; to continue to develop and implement clear goals, vision, principles, roles and responsibilities, process and subprocess designs, and performance metrics that enable the effective use of the Institute's I/T resources; and to achieve the benefits of transforming the Institute's I/T enterprise by fully realizing the I/T Transformation Redesign Team's vision of IS and all of the Institute's centralized I/T as a process-centered, team-based organization.

In the two years since the launch of I/T Transformation, the Information Technology Leadership Team, led by the Vice President for Information Systems, has worked to implement the redesign team's vision. Over the past year, Information Systems staff moved more fully into IS's new team-oriented, process-driven framework and continued to work with others throughout the Institute in ongoing activities and new initiatives. IS staff remain deeply involved in efforts to reengineer the Institute's administrative processes. By the end of the fiscal year, IS staff had achieved an impressive range of accomplishments, some of which are highlighted in the reports which follow. This section presents an IS overview.

Use of MIT's information technology resources continues to grow as the I/T infrastructure is improved and expanded. Annually the MIT community comes to IS with some 100,000 requests for help and service changes, ranging widely from upgrading telephone service to installing a new office computing environment to assisting faculty in using computers in their teaching. In fiscal 1997, Quickstations and ZIP drives were introduced into the Athena Computing Environment; administrative servers averaged 99.84% daily availability despite increasingly heavy network traffic; over 500 hands-on courses, Quick Start classes, and Athena mini-courses reached thousands of participants from across the MIT community; and the Computing Help Desk handled over 20,000 cases while reducing its daily queue of pending cases by 80% through process and efficiency improvements. In addition, IS successfully delivered I/T products, such as SAPweb and Alumni "E-mail-Forwarding-For-Life," that were immediately valuable to the MIT community.

There were some changes to the I/T Leadership Team during fiscal 1997, although its core remained the same:

- Leaders of I/T Practices advocate both on behalf of customers to IS and on behalf of IS to customers. In October 1996, Theresa M. Regan succeeded Diane Devlin as Director, Office Computing Practice. She joins two other practice directors: M. S. Vijay Kumar, Director, Academic Computing Practice; and Dennis Baron, Director, Voice, Data, and Image Networking Practice.
- Greg Anderson as Director, I/T Discovery; Robert V. Ferrara as IS's newly appointed Director, I/T Delivery; Roger A. Roach as Director, I/T Service; William F. Hogue as Director, I/T Support; and Susan Minai-Azary as Director, I/T Integration are responsible for IS's core work process.
- I/T Competency Group leaders concentrate on the skills dimension of Information Systems, working to provide a staff well-qualified to meet future work requirements. Late in fiscal 1997, Erin Rae Hoffer and Shirley M. Picardi left Information Systems. Until a new director is appointed, Greg Anderson will act as Interim Director, I/T Competency Groups. He is charged with leading a team chartered to discover future directions for the competency concept in IS.

Over the next year, the I/T Leadership Team will continue a series of meetings designed to understand and refine IS's process-centered organization. The I/T Leadership Team and the IS staff are committed to continuing to learn our way into working in the new framework and to ensuring that the new framework works for us, for our customers, and for the Institute. More information about Information Systems may be found on the World Wide Web at the following URL: <http://web.mit.edu/is/>

James D. Bruce

ACADEMIC COMPUTING PRACTICE

The Academic Computing Practice seeks to promote and enable MIT education through the effective use of information technology. Collaborating with I/T Process teams and in partnership with academic departments, the Academic Computing Practice provides widely distributed client-server computing designed to facilitate undergraduate education. This occurs primarily through the Athena Computing Environment, which is used by thousands of users each day and over 10,000 different people on peak days. Academic Computing also provides advocacy, training, documentation, and consulting services to support academic work. During fiscal 1997:

- The Academic Computing Practice continued its annual renewal of Athena equipment, purchasing workstations and peripherals to replace aging equipment. In this renewal effort, 144 Sun SPARC4 workstations and 46 SGI workstations were deployed to public clusters, and 82 SPARC4 workstations and 33 SGI workstations were deployed to academic departments. In March 1997, the historic "Fishbowl," the Building 11 Athena cluster, moved to Building 12 to accommodate the new Student Services Center, and the Building 16 basement cluster moved to its new location in the renovated Building 56. Other Athena cluster enhancements in fiscal 1997 included the installation of Quickstations and ZIP drives in clusters around campus.
- Academic Computing encouraged and supported innovative educational uses of technology. As part of the Athena Renewal process, Academic Computing solicited instructional computing-related proposals from academic departments. Projects being supported through this initiative include the development of a Web-based program for freshman Calculus. Academic Computing also contributed to MIT's successful bid for Intel Corporation equipment to support computationally-intensive applications, proposing that IS help develop a remotely-manageable, serially-reusable Windows NT environment. Academic Computing continues to collaborate with the Department of Civil and Environmental Engineering on this initiative.
- To anticipate and meet the network requirements of a growing number of high-bandwidth instructional applications, Academic Computing led IS's participation in the Internet 2 initiative and contributed to MIT's successful NSF proposal for a vBNS (Very High Bandwidth Network Service) network connection.
- Also in fiscal 1997, Academic Computing coordinated MIT's membership in the New Media Centers Consortium, a nonprofit organization designed to bring together academe and industry to create a collaborative network that integrates media into education. As a member of the Consortium, MIT will benefit from multimedia development at other colleges and universities. MIT will also be able to equip a hands-on laboratory with state-of-the-art technology for multimedia development and training. The new Media Center will allow faculty to create and use instructional materials and workshops that require multimedia-based software; it will also allow them to assign media-based homework such as digital photography or audio/video editing.
- The Academic Computing Practice provided a strategic focus for information technology in education in Institute-wide planning and policy-making groups, including the Council on Educational Technology, the Task Force on Student Life and Learning, and the Faculty Policy group. Partnering with the Resource Development Office and I/T Discovery, Academic Computing developed a proposal for an Advanced Visualization Initiative. With the Office of the Dean of Students and Undergraduate Education, Academic Computing initiated Crosstalk, a forum for technology and pedagogy. The Practice also collaborated with the Center for Advanced Educational Services and the Registrar's Office on projects concerning instruction support and electronic classrooms.
- The Academic Computing Practice continued outreach efforts to external professional organizations, including NERCOMP, CAUSE, EDUCOM, Seminars on Academic Computing, IVY+, and the American Association for Higher Education, and key technology vendors, including Apple, IBM, ORACLE, SGI, SUN, and Intel. Academic Computing also hosted visitors from Australia, Germany, Japan, Israel, and Malaysia who were interested in MIT's academic computing program.

M. S. Vijay Kumar

OFFICE COMPUTING PRACTICE

During fiscal 1997, the Office Computing Practice continued its efforts to ensure that administrative computing customers and providers derive maximum value from MIT's information technology resources. Collaborating with I/T Process teams and in partnership with administrative offices and departments, the Office Computing Practice works to build constructive relationships with individuals and organizational units that share the Institute's administrative responsibilities towards its primary mission of research and education. The work of this Practice relies on a solid and current understanding of office computing needs, opportunities, and priorities. These are essential to discovering, implementing, and supporting the best applications of information technology for the administrative computing environment.

- Complementing its primary purpose of advocating on behalf of customers with IS, and on behalf of IS with customers, the Office Computing Practice devoted a substantial amount of time in fiscal 1997 to meeting directly with administrative customers to assess their I/T needs. Throughout the year, Office Computing worked closely with groups from the central administrative offices and academic departments, and met with most of the Administrative Officers from each of the Schools. These meetings provided an opportunity to exchange ideas, address issues, and strive for a standard cross-platform administrative desktop computing environment. Discussions spanned work on-campus, off-campus, and between campus and colleagues on other campuses.
- During fiscal 1997, the Office Computing Management Group (OCMG) emerged as a forum for IS and other administrative I/T staff to meet, share ideas and information, discuss issues of mutual concern, and plan together for the future. The Office Practice hopes to generate more sustaining interest in this group across MIT.
- To a large extent, MIT's reengineering initiative has meant a reexamination of MIT's business practices. This, combined with shifting work demands, has created a rapidly changing environment for the Institute's administrative processes. This past year, the Office Computing Practice conducted strategic planning meetings in major administrative areas, including the Controller's Accounting Office (CAO), the General Purchasing Office (GPO), the Budget Office, and the Vice President for Human Resources' area, to prepare for the delivery of reengineered business applications with a primary focus on SAP R/3. Collaborating with administrative customers and IS teams in Service and Support, the Office Computing Practice coordinated reengineering-related planning for MIT's central administrative groups and the MIT Professional Learning Center, including the deployment of over 300 new desktop computers. These computers were delivered with administrative software and networking installations as needed.
- Throughout the year, the Office Computing Practice also championed the introduction of the Windows NT workstation as a supported operating system for administrative desktops. This effort involved close collaboration with Service and Support teams. Early in the spring, IS announced gradual support for Windows NT commencing in July 1997, with full support anticipated in early fall 1997.

Theresa M. Regan

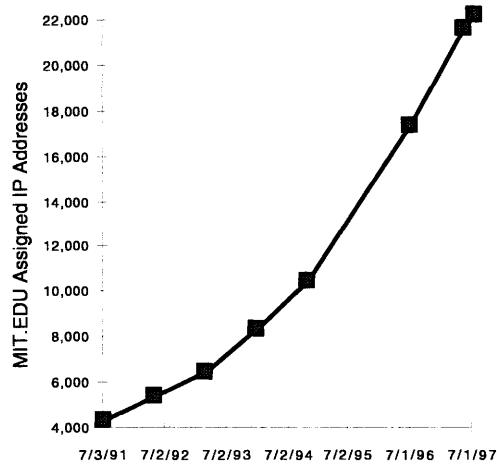
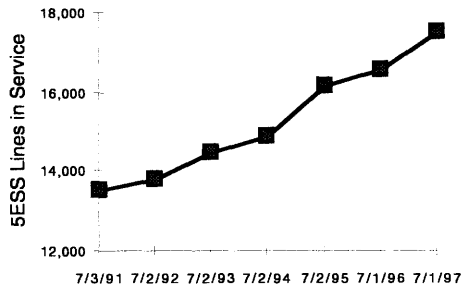
VOICE, DATA, AND IMAGE NETWORKING PRACTICE

The mission of the Voice, Data, and Image Networking Practice is to ensure that the necessary information technology systems and services are available to support academic, research, and administrative efforts at MIT. This includes working with IS process owners and outside vendors to make sure current systems are accessible and have adequate capacity. In addition, this Practice helps identify needs for new communications technologies and facilitates their availability to meet future needs.

In its first year, the Voice, Data, and Image (VDI) Networking Practice concentrated on building relationships and identifying opportunities. Within IS, work has focused on building relationships with and between the teams working in the I/T processes. In conjunction with the Academic Computing Practice, the VDI Practice initiated a series of conversations with several academic departments and consulted with students about MITnet service to the Independent Living Groups (ILGs) and telephone service to on-campus residents. Outside MIT, the VDI Practice participated in IVY+ and Boston/Mellon Consortium meetings.

Throughout the year, the Voice, Data, and Image Networking Practice sought to identify opportunities for improvements:

- Demands on MIT's communications infrastructure continue to grow (see graphs below). MIT must continue to invest in its voice, data, and video (image) networks to ensure that there is adequate capacity for future demands. At the same time, we must introduce new services and upgrade old ones to meet new needs.
- The Telecommunications Act of 1996 and other changes, both internal and external to the Institute, continue to apply pressure to MIT's business and cost recovery models. While the demands for and costs of services have changed dramatically, the Institute has continued to use rate models that were developed under different market conditions. We must take a fresh look at how to recover the cost of the communications services we provide.
- In the wake of the reengineering effort that transformed Information Systems into a process-centered organization, we must continue to improve work processes to ensure that IS provides timely and cost-effective services. We must improve coordination and planning both within IS and with other departments, such as Physical Plant.



Dennis Baron

I/T DISCOVERY PROCESS

The I/T Discovery Process continued to build on customer-IS partnerships during its second year. In particular, it focused on promulgating the “discovery” approach throughout IS and around the Institute. The discovery approach is an established method for linking information technology to business strategies and customer needs. Collaborating with academic, office, and voice/data/imaging clients, Discovery works to find and implement information technology that adds value to MIT's business processes, while reducing work and lowering costs. Discovery promotes a shared vision of I/T based on best practices and business analysis, a conceptual design, and resource commitments. Recommendations from Discovery projects set the stage for accelerated work within Delivery, Integration, Service, and Support.

Discovery takes many different forms—a formal project, a less formal project, or sometimes just work going on elsewhere in the organization. It extends across all of MIT, including areas with or without resident I/T capability, and it adds value to MIT strategic or tactical goals. Discovery project timelines vary between a couple of hours to two months, and projects can occur in large formal teams or small quasi-formal teams, as well as everything in-between. As an approach, Discovery may be applied to many types of challenges—organizational changes, technological opportunities, physical relocations, etc. It aims to align work properly at the outset for accelerated productivity through the I/T work processes, and to provide a key link between Information Systems and its customers, as well as between MIT business leaders and their customers.

Discovery teams were involved in almost thirty different projects during fiscal 1997, spanning almost all areas of the Institute. Discovery teams contributed to core Reengineering initiatives, including Management Reporting/Financial Operations/Buy-Pay and Student Services, as well as other projects with key customers and high MIT profiles. These included:

- Admissions Office recommendations regarding undergraduate and graduate admissions;
- SAPweb initiative to provide Web-based access to SAP report data for purchase orders, invoice, and payment information to the entire MIT community;
- Restructuring of the Microcomputer Center, including a new design for electronic commerce at MIT;
- Planning the Year 2000 Project at MIT;
- Support plan as part of the MIT recommendation to use Microsoft NT on Intel-based desktops;
- Athena Quickstations to provide quick access to commonly-used Athena services;
- Redesign of the Subject/Teacher Evaluation process;
- Investigations into imaging capabilities for administrative functions in the Dean for Students and Undergraduate Education's organization and for CAO invoicing processes.

Other projects included an initial design to incorporate course lotteries into the electronic pre-registration process, the creation of a resource development proposal for Advanced Visualization, the continued exploration for an Institute-wide calendaring/scheduling facility, and work with the Communications Office to place MIT Office Directory information on-line.

In fiscal 1997, Discovery achieved an identity as a valued I/T service at MIT. It has established credibility with customers and IS. In fiscal 1998, Discovery will continue to improve and extend its influence and methods in order to assist MIT's goals for consistent, productive, and efficient I/T work.

Greg Anderson

I/T DELIVERY PROCESS

As the second of the five work processes, the I/T Delivery Process exists so that MIT and its schools, departments, laboratories, and centers can realize business value as rapidly as possible from the implementation of new information technology products and services.

- This past year saw the successful conclusion of many Delivery projects, with a special concentration of Web-based applications. SAPweb, a set of display-only transactions allowing access to SAP purchasing data, was made generally available to the MIT community late in the fiscal year; response was overwhelmingly positive. In March 1997, the web-based Electronic Catalog (ECAT) system went into production use, bringing advanced electronic shopping to MIT. Also in this fiscal year, web registration for Alumni "E-mail-Forwarding-For-Life" was successfully introduced to an even larger audience of MIT Alumni/ae.
- Delivery devoted time and effort to supporting the SAP Release One rollout on September 3, 1996. In addition to Web-based extensions, SAP activities included launching a technical documentation project, running two in-house courses for MIT technical staff, and supporting the MIT-developed Labor Distribution System. A major expansion of the MIT Data Warehouse was also begun with the addition of SAP's data in a pilot sponsored by six major research laboratories. The full-scale Warehouse project, including advanced reporting tools, is on schedule to be deployed in early calendar 1998 to the sponsoring research laboratories. Complete Warehouse access for the rest of the MIT community will follow about two months after each department receives full SAP functionality.

-
- On the academic side, the Athena Software Delivery team updated the Athena Computing Environment to a newer version of system software from Sun and prepared for transition to a “unified” version of system software from SGI. The team phased out the IBM RS/6000 and Digital DECStation hardware from Athena’s public cluster infrastructure and contributed to the Quickstation effort, providing “kiosk”-style workstation access in the Athena Environment. The team also made significant progress toward a “stock” AFS file system, which will make all current AFS upgrades easier, including the 3.4a upgrade currently underway.
 - Several new applications and subsystems were delivered for MIT’s primary personal computer platforms. Versions of the authentication/encryption routine, Ksign, were delivered as components on all major platforms, enabling use of the Electronic Catalog. Secure versions of the terminal emulation programs, TN3270 and Telnet, were delivered to the Windows user community. These products reduce the exposure of passwords on the MIT network, allowing the retirement of separate dedicated “secure” networks; it is the result of a long-term cooperative effort between MIT-IS and Hummingbird Communications, Ltd., of Canada.
 - Currently, a Delivery team is working to complete the major Electronic Proposal Submission System in early calendar 1998. The system is an integral part of the Office of Sponsored Programs’ COEUS system and will be deployed on hundreds of research desktops throughout MIT and many more at kindred institutions. In August, new technology designs will be rolled out to enhance the Writing Requirement and to support the MIT Procurement Card pilot. The work of SAP’s Rollout98 continues, as does the deepening of MIT’s partnership with SAP to develop security- and Web-based features for the SAP environment.
 - Since fiscal 1997 was also Delivery’s first year of operation under a new Director, considerable effort was spent defining the normal process of project delivery. Major progress was made on several fronts. A Projects Database was designed, developed, and made operational; this Web-accessible database now houses summary information and pointers to information for all 23 Delivery projects, as well as data on all other significant I/S projects. Next year it will be expanded to include non-I/S projects as well. A Delivery Process Map was also defined, and the Delivery web pages were populated with help and illustrations. Regular Team Leaders meetings were begun, and coordination points with all I/T Processes and I/T partners were established. Delivery is now definitely “open for business.”

Robert V. Ferrara

I/T SERVICE PROCESS

The core mission of the I/T Service Process is to manage MIT’s information technology infrastructure reliably and efficiently. This infrastructure includes the datacenter in W91, MITnet, telephone and related services, the Athena Computing Environment, database services, and desktop maintenance (PC repair) services. During the past year, I/T Service teams in each of these areas reached significant milestones.

- Despite continued increases in the number of administrative servers and also despite required system outages for upgrades, all administrative servers in the datacenter averaged 99.84% availability. Increased automation efforts and new technology reduced mainframe-related costs and allowed resources previously used for mainframe support to transition to supporting the new servers. To enhance and protect the Institute’s datacenter infrastructure, an emergency power system for Building W91 was designed and approved, and significant physical security enhancements were implemented.
- MITnet usage continued to grow in fiscal 1997. To accommodate increased network traffic (approximately 250,000 electronic messages are processed daily, for example), the network’s backbone routers were replaced with newer, faster models, and an FDDI Switch was added to the backbone to improve overall network “throughput.” The Network Software group helped design and implement a new process for managing the “net dist” server; this new process ensures that “net dist” remains a reliable and efficient means for distributing third-party software to the MIT community with adequate access control.

-
- Usage of the 5ESS also continued to grow. During the past year, Service teams provided MITnet and 5ESS telephone service to newly constructed or renovated buildings around MIT, including 320 Charles Street, Senior House, Building 56, and 5 Cambridge Center. Service also conducted major software upgrades for the telephone switch, the Automated Call Distribution (ACD) system, and the Voice Mail system. New radio systems were acquired and installed for Campus Police and Physical Plant.
 - The Athena Server Operations (ASO) team continued the on-going process of upgrading the oldest of their more than one hundred servers. These upgrades resulted in user-visible improvements in the speed of some services and improvements in the maintainability of others. ASO also increased the level of automation of their backup systems, allowing data to be backed up more often while requiring fewer staff-hours. Improvements were also made in automated monitoring systems which reduced response times when system problems occurred.
 - In addition to providing Athena hardware repair and maintenance services, Cluster Services deployed well over 300 Athena systems over the past year, mostly during August 1996. Cluster Services also partnered with the Academic Computing Practice and the Athena Software Delivery team to deploy new services, such as Athena Quickstations and Zip drives in Athena clusters and to coordinate various Athena cluster moves.
 - The Database Services Team worked with the Institute's major administrative departments to maintain over 75 databases supporting SAP, Admissions, Alumni, Payroll, Pension, Personnel, IS-telecommunications, among others.
 - During the past year, Desktop Maintenance Services (PC Repair) continued to repair hardware and maintain software for the MIT community. Desktop Maintenance Services now offers services for Apple and Dell microcomputers; HP printers; and DEC, Sun, SGI, and HP workstations.
 - Service teams remained deeply involved in reengineering efforts. Two significant projects during the past year were the "cutover" of MIT's central financial offices to SAP R/3 and the upgrade of that system to its latest software release, SAP R/3 3.0f. To support SAP Training, Service augmented the existing SAP servers with additional disk and processing capacity.

Roger A. Roach

I/T SUPPORT PROCESS

The core mission of the I/T Support Process is the effective and efficient delivery of high-quality support services to the Institute's information technology users. Support is provided by a variety of standing teams: I/T Help Desk; Training and Publications; Desktop Products; Adaptive Technology Support (ATIC Lab); Departmental Computing Support; Campuswide Information Systems Support (CWIS); Athena Help/Residential Computing Consulting; Academic Computing Support; 5ESS Support; and Support Team Headquarters.

To better identify and refine support services, Support team members work to improve the help process by listening carefully to customers and balancing customer feedback with Institute goals and resource availability. While focused on different aspects of users' needs, the highly qualified staff on these teams share a common commitment to the I/T Support mission. During 1996-97:

- The Help Desk reduced the average daily queue of pending customer requests (logs) by over 80%, initiated a program of regularly scheduled training and professional development for team members, and simplified work flow through process improvements. A new Help Desk team leader was appointed in October 1996.
- An I/T Partners program involving about 80 MIT staff was initiated. I/T Partners are local experts—staff in departments, laboratories, and centers—who act as an initial point-of-contact for I/T issues and share their I/T knowledge among colleagues at the department or office level. In addition to meeting as a group twice annually, I/T Partners have formed a steering committee and various special interest groups. A pilot program now

underway gives a subset of I/T Partners priority access to Help Desk consultants, and I/T Partners have access to IS Training courses free of charge.

- Support has been deeply involved in SAP Rollout efforts for the entire year. Documentation, training, help desk support, one-on-one consulting, deployment and configuration of desktops, and user accounts all have contributed to the success of this Institute-wide effort.

William F. Hogue

I/T INTEGRATION PROCESS

The mission of I/T Integration is to implement an information technology infrastructure that has high levels of reliability, availability, and serviceability; provides excellent price/performance; meets current MIT needs and can quickly adapt to meet future needs; and enables the effective performance of the other I/T processes. During the past year, teams working in the Integration Process made progress on several fronts.

- The Integration Team worked to educate software designers about MIT's current information technology infrastructure. The lunch seminar series begun last year continued in fiscal 1997 with topics covering web development, web security, data modeling, software version control, the MIT Data Warehouse, and the Roles database design. Also during the past year, the Integration Team purchased bulk training units for selected developer tools so that all MIT developers could share in training at reduced cost. Strategies like shared training, web pages aimed at MIT's software developer community, and IAP seminars on I/T infrastructure and security issues exemplify Integration's ongoing education efforts.
- Integration standing teams also acted as consultants for designers and developers. Over the past year, Data Administrators helped with data modeling for new systems, and Integration team members reviewed and advised on designs for new systems. (Integration staff check high-level process- and data-models to ensure that teams from across IS and MIT develop systems that are independent or well-integrated and adhere to MIT's current I/T standards and practices. Early work with Discovery teams also helps Integration teams understand future infrastructure needs.) Working with developers, the Data Administration Team extended the MIT data model and added shared data and new views to the Data Warehouse. Also in fiscal 1997, the Integration Laboratory, which is available to the MIT community for testing changes that affect the MIT administrative application set, moved to Building E19. The Security Officer facilitated work with the Institute Physical Security Coordination team to arrive at a draft security policy for MIT.
- Integration project teams worked both to update current I/T infrastructure components and to build new ones. This past year saw the completion of Release One of the Kerberos Version 5 (V5) project for internal and external use. The Kerberos team also developed a version 4-compatible administration server to aid in the migration to version 5. Kerberos V5 shared libraries were created which use a version server to track and control usage. A project to implement MIT certificates for web application authentication was completed and used by project teams in Student Services, Management Reporting/Financial Operations, and IS. The Data Warehouse team standardized the infrastructure around managing data loads and conversions in preparation for the large Delivery project with several MIT research laboratories. They also selected a data access tool for Warehouse access and arranged a license for MIT. A project team, chartered to develop the philosophy for installing software on desktops was active this past year, developed tools to build installers and purchased a site license for a Macintosh installer-making tool.
- One goal of the Integration process is to propagate strategic MIT technology to vendors of commercial products and to other users outside MIT. Team members continue to play a leadership role in the Internet Engineering Task Force which sets Internet standards. By exerting influence in strategic areas, such as network security in open-network environments, MIT has the opportunity in the future to buy (rather than build) its preferred I/T infrastructure components and applications. Intending to encourage a standard for network security, the Integration Process made Kerberos Version 5 freely available beyond MIT in fiscal 1997, and held a Kerberos workshop for vendors and other users and developers of Kerberos code. MIT's Kerberos version 4 and 5 developers for Macintosh and Windows operating systems helped coordinate development efforts across several academic sites and worked with commercial vendors to ensure that products incorporating Kerberos would

interoperate. MIT developers successfully influenced Microsoft to commit to releasing the specifications for their proprietary extensions to the Kerberos protocol; they continue their attempts to influence Microsoft into incorporating a version of Kerberos into its next version of Windows NT that will interoperate with MIT's. Similarly, Integration team members are working to influence Sybase Powersoft to incorporate network security in their Distributed Object technology, Apple to incorporate MIT's requirements in their next operating system, and SAP AG to support the use of strong authentication and encryption using X.509 certificates in the design of their Internet Transaction Server (ITS).

Susan S. Minai-Azary

I/T COMPETENCY GROUPS

The I/T Competency Team works to ensure that appropriately skilled human resources are available to staff MIT's I/T processes and projects. Throughout the past year, the I/T Competency Team focused on four primary activities:

- **Strategy and Communications:** Data gathered from in-depth interviews with I/T staff throughout the summer of 1996 was integrated into a descriptive model of I/T competency, which defined behavioral competencies linked to high performance. This model was communicated to I/T teams and team leaders, as well as to other interested groups across the Institute. Later in the year, the Competency Team developed a workplan for I/T Competency, proposing 18 months of strategies and initiatives. Along with other members of the I/T Leadership Team, Competency directors participated in a series of meetings designed to build deeper internal understanding and refinement of the IS organizational model.
- **Development and Training:** Project Management training, initiated in fiscal 1996, was continued in fiscal 1997; in total, 60 I/T staff participated in the eight-day course. With the aid of the Hay Group, the Competency Team developed a workshop on competency-based interviewing, offering it to 26 I/T staff members; this technique was applied by a number of hiring team leaders to gain deeper insights into the strengths and weaknesses of candidates. In collaboration with Brian McDonald of MOR Associates, the Competency Team offered a workshop on coaching to 19 I/T staff members; attendees responded with positive feedback and recommended that similar workshops be offered in the future. The Competency Team also designed a process and instrument to support individual competency self-assessment by I/T staff. Feedback from directors and team leaders was gathered to support the rollout of I/T self-assessment and to refine an accompanying list of development recommendations. Also during fiscal 1997, the Competency Team collected the goals information resulting from the annual performance appraisal process into a database as preparation for the self-assessment process and to inform the prioritization of competency group initiatives. Members of the Competency Team continued to sponsor monthly meetings of IS team leaders, developing agendas and programs on human resources reengineering efforts, project management database development, coaching techniques, and the like.
- **Human Resource Initiatives:** MIT's I/T openings were aggressively marketed in area newspapers, trade publications, and at a technical career fair. An Exit Interview form was developed to be used in interviews with departing IS staff; the Competency Team plans to aggregate information gathered from these interviews into a report to the I/T Leadership Team that should inform the development of staff retention programs. The Competency Team met with human resources staff at Harvard University to discuss successful strategies for the hiring and retention of I/T professionals. The Competency Team also worked with team leaders and directors to propose revisions to IS's performance appraisal form and process, and workshops were offered to introduce staff to the revised process.
- **Outreach:** Through information exchange with staff in the Personnel Office, MIT's Human Resources Practices Design (HPRD) team, MIT's Training and Development team, MIT's Student Services reengineering team, and Physical Plant, the Competency Team reached out to the Institute to share results and gather feedback. Towards the middle of the year, the team's work was presented at a Florida-based conference on Human Resources in I/T organizations. Throughout the year, members of the Competency Team learned about best practices by attending workshops and conferences on assessment and measurement, on competency definition, and on human resource practices. In addition, contact with other leading institutions, such as the University of Michigan, informed I/T strategy development.

During the coming year, I/T Competency will face the challenge of transitioning to new leadership with the departures of Shirley M. Picardi and Erin Rae Hoffer, and with the appointment of Kathryn T. Kibbee as Project Manager, IS Training and Development. During the summer, acting director of I/T Competency, Greg Anderson will be spearheading the efforts of a team of staff from IS and HRPD to define next steps. Their efforts will be closely linked to the I/T Leadership Team's proposals for improvements to overall IS organization and practices.

Katherine K. Allen, Erin Rae Hoffer, Kathryn T. Kibbee, and Shirley M. Picardi

VICE PRESIDENT FOR RESOURCE DEVELOPMENT

Private support to MIT during FY97 continued to set new records for Institute fundraising, reflecting the increasing strength of giving from alumni and friends. Such extraordinary results are the product of a strong partnership between Resource Development and the Alumni/ae Association, the senior officers, deans, department heads, faculty and volunteers, and are an important base on which to build the success of our fundraising future.

As the Institute considers the priorities and timing of a capital campaign, Resource Development has begun the early preparation and planning, both organizationally and with individual, corporate and foundation donors, to coordinate and sustain this accelerated fundraising program.

Over the past year, staffing remained relatively stable. There were 15 promotions (10 men and 5 women, including 3 minorities) and 8 open staff positions were filled including 4 women. One position was created in the Office of Principal Gifts. Resource Development continued its effort to fill positions with qualified women and minority candidates working closely with Personnel and others to identify new resources from which to draw applicants. A minority intern from CASE (Council for the Advancement and Support of Education) was hired in a full-time position in the Donor Relations group. Resource Development remains committed to the hiring and promotion goals set out in our Affirmative Action report.

Private support for Fiscal Year 1997 totaled \$133.6 million, including the following: \$126.2 million in gifts, grants, and bequests, and \$7.4 million in support through membership in the Industrial Liaison Program. The total compares with \$130.9 million in 1996, \$108.9 million in 1995, \$94.5 million in 1994, and \$96.8 million in 1993. Gifts-in-kind for the past year (principally gifts of equipment) were valued at \$11.2 million.

Sources of gifts for Fiscal Year 1997 were: alumni, \$48.9 million; non-alumni friends, \$17.8 million; corporations, corporate foundations, and trade associations, \$30.2 million; foundations and charitable trusts, \$27.7 million; and others, \$1.6 million.

Donors designated expendable and endowed funds as follows: unrestricted, \$15.6 million; departments, \$47.6 million; faculty salaries, \$20.7 million; graduate student aid, \$8.8 million; undergraduate student aid, \$14.7 million; building construction funds, \$3.5 million; and other funds \$15.3 million.

Barbara G. Stowe

OFFICE OF INDIVIDUAL GIVING

The Office of Individual Giving, directed by H.E. (George) Ramonat, continued to cultivate, solicit and steward individual prospects and donors to the Institute. The staff includes major gift officers, assigned regionally across the United States, Canada, and the Pacific Rim, the development officer for the arts, the associate director of gifts planning, the manager of the Emma Rogers Society, as well as administrative and support staff.

Working towards the goals outlined in their strategic plans, the field officers sustained the high pace of prospect activity that has been a mark of the office since the end of the *Campaign for the future* in 1992. In addition, they worked to better prepare the Institute's individual giving effort for the next campaign, i.e., increased utilization and recruitment of volunteers associated with activities of the Corporation Development Committee (CDC), and the engagement and involvement of new constituencies—primarily the entrepreneurial founders' community and those who would be prospects for a planned giving approach.

At the annual meeting in November 1996 and again at the April 1997 meeting of the Corporation Development Committee Advisory Group (CDC), President Vest and Vice President Barbara Stowe engaged the membership in a dialogue about issues related to the purpose, timing and goals of the next capital campaign. Regional CDC meetings were also held throughout the year to strengthen the feeling of "family" among these volunteers.

H.E. Ramonat

OFFICE OF PRINCIPAL GIFTS

Under the direction of Lucy Miller, the Office of Principal Gifts continued to deepen and strengthen relationships between the Institute's most generous benefactors, and the senior administration and faculty.

Multi-million dollar commitments were secured to support top priorities of the Institute, including professorships, fellowships, the new athletic facility and the new computing, information, and intelligence sciences building. In collaboration with representatives from the Undergraduate Research Opportunities Program (UROP), the Office of Individual Giving, the Alumni Association, and the Treasurer's Office, Principal Gifts directed the campaign to endow a fund for UROP in honor of Paul E. Gray 's, '54, thirty-one years of administrative service to MIT.

To better inform and engage the most dedicated supporters of the Institute, this office helped President Vest establish the President's Council, a small group of close alumni/ae and friends gathered to offer their perspectives as MIT moves into the 21st century.

Given the central importance of principal giving in securing private support for MIT, a principal gifts officer was added to the staff.

Lucy V. Miller

OFFICE OF COMMUNICATIONS AND DONOR RELATIONS

This office, known as COMDOR, is headed by Elizabeth Harding. It provides editorial and event planning support for the fundraising staff, and coordinates major gift stewardship at MIT.

A key task of the year was to help organize a gala, held in May, to provide MIT's most generous donors with an opportunity to honor Paul and Priscilla Gray as Dr. Gray stepped down from his administrative duties at the Institute. A special program with faculty and students preceded the event. Over 350 people attended a reception and dinner hosted by President and Mrs. Vest. Representatives from the offices of the President, the Corporation, Individual Giving, Principal Gifts and Mrs. Vest all helped COMDOR plan and coordinate this special party.

The Office of Events within COMDOR also helped organize 53 Resource Development events, including spring and fall Campus Visits, a series that introduces donors and prospective donors to current research and educational programs. The staff, at the request of the Office of Government and Community Relations, organized a dinner hosted by the Chairman of the Corporation in honor of the Prime Minister of Malaysia. This year they also coordinated the logistics for the Corporate Relations Advisory Panel in October and the first President's Council in May.

COMDOR continued to publish *Spectrum*, a 16-page tabloid newspaper with a circulation of over 30,000, including donors to MIT, faculty and staff. Two issues were published this past fiscal year; one focused on teaching and the other on diversity. The editorial group published *MIT Facts*, a new brochure on the UROP program, two newsletters for the Emma Rogers Society, and assisted the Office of Foundation Relations with a number of preliminary and final proposals and an overview of minority programs at MIT. Development of a World Wide Web page for Resource Development also began; it will be on-line as part of the Alumni/ae Association pages by late summer of 1997. Once again, the staff produced eight full-page advertisements in *Technology Review* profiling alumni/ae who have established life income funds.

Stewardship activities included the coordination of appreciation letters from the President and the Chairman to major donors to the Institute. In addition, the staff served as a clearinghouse for the approval and production of all plaques mounted within MIT to commemorate either gifts or the special service of faculty and staff.

COMDOR continued to refine and expand systematic stewardship programs for scholarships and UROP, and to facilitate fundraising for financial aid. The stewardship manager prepared a reference book to assist front-line staff and volunteers in winning support for this top priority. She also prepared 150 reports to scholarship donors and helped plan two cultivation dinners as well as over a dozen meetings between donors and the scholars they support.

Elizabeth T. Harding

Vice President for Resource Development

MIT Reports to the President 1996-97 – 503

OFFICE OF DEVELOPMENT RESEARCH AND SYSTEMS

This office, headed by Shelley Brown, provided research and systems support for initiatives meant to prepare Resource Development for the next campaign.

The conversion to a new alumni/ae database continued for the third year. The management team overseeing this effort; including senior management and information systems staff from the Alumni/ae Information Services, the Recording Secretary's Office, Development Research and Systems, with support from the IS staff; completed data mapping and conversion processes and a department-wide upgrade of hardware and software. Efforts to develop and document policies and procedures, and design a training program are well underway. Work is scheduled for completion by the close of FY98.

The Alumni/ae National Screening program continued to coordinate screening sessions across the country. Ten sessions were hosted and attended by key alumni/ae volunteers in Cape Cod, MA; Long Island, NY; Greenwich, CT; Seattle, WA; Sunnyvale, Los Angeles, and Orange County, CA; and Atlanta, GA. In collaboration with the Office of School Development Services and the Assistant Dean for Development in Engineering, the office also planned and conducted a series of screening sessions attended by EECS faculty.

The two-year MIT Founders Project, conducted in partnership with the MIT News Office and in collaboration with BankBoston, successfully concluded this year. The BankBoston Economics Department Special Report titled *MIT: The Impact of Innovation* was released in March and distributed widely among selected MIT constituencies, key members of the federal, state, and local governments, and leaders in the corporate, academic, and foundation sectors.

In addition to providing ongoing research, technology, and programming support for Resource Development, the office prepared a targeted analysis of the Institute's pool of potential prospects, with an eye toward quantifying and tracking their philanthropic capabilities.

Shelley Brown

OFFICE OF FOUNDATION RELATIONS AND SCHOOL DEVELOPMENT SERVICES

Under the direction of John Wilson, gifts from private foundations for this fiscal year totaled more than \$32 million, up 9% from FY96, and continued to provide significant support for MIT's educational and research programs. Major grants or pledges were received in support of a new W.M. Keck Neural Prosthesis Research Center, the MIT International Science and Technology Initiative (MISTI), the Museum Art Loan Project, and a series of conferences on the topic "Media in Transition."

The Office of School Development Services (OSDS) continued to support the fundraising efforts of the five schools and the Office of Academic Development. In support of the Alliance for Global Sustainability (AGS) OSDS prepared the first draft of a "briefing document", since distributed to many prospective donors, and assisted with the AGS meeting held in January 1997 at MIT.

OSDS also cultivated and solicited alumni/ae of the Sloan School of Management for the Dean's Fund for Preeminence, and assisted with the first annual dinner for this constituency. In addition, this office wrote approximately 70 research reports for Dean Glen Urban, including a benchmark study comparing entrepreneurship centers at five universities.

Due to OSDS support, the School of Architecture and Planning increased the number of donors to the Dean's Council, and assisted with a special mailing to seek additional support for the Paul Sun Endowment Fund to convert it to a fellowship.

On behalf of the School of Humanities and Social Sciences and in collaboration with Dean Phil Khoury, this office conducted alumni screenings, generated prospect lists for trips and events, and completed a major statistical analysis of donors and gifts.

OSDS assisted the School of Science with the President's dinner to honor donors of the Simons Professorship of Mathematics and the Novartis Symposium. This office also helped place the MIT Chemistry 2000 campaign within reach of its \$4 million fundraising goal.

For the School of Engineering, OSDS provided research for more than 40 Dean, Assistant Dean, and faculty visits, as well as for many fundraising and stewardship events. The office assisted with the Campus Visit in April and coordinated receptions for the Design 2.007 Competition and the \$50K Competition. In support of the fundraising campaign for the Computing Information and Intelligence Sciences Building, OSDS coordinated screening sessions with the faculty and created a database to track prospects for the building.

OSDS continued to maintain and update the full series of academic department profiles for each school, as well as primers describing major programs or projects in the schools. This office also continued to run a monthly FYI series highlighting major academic initiatives. Guest presenters included: Deans Philip Khoury, Robert Brown, and Rosalind Williams, Professor Suzanne Berger, and School Development Officer Lee Ann Day.

John S. Wilson, Jr.

OFFICE OF CORPORATE RELATIONS

The Office of Corporate Relations (OCR), directed by Thomas Moebus, continued to support faculty in creating larger corporate relationships, expanding international programs, and increasing industrially sponsored research, while maintaining the health of the Industrial Liaison Program and improving its product offerings. Several important corporate partnerships and new international programs began, and MIT's level of industrial research funding reached its highest level, at over \$77 million. Cash gifts to MIT totaled \$28.5 million; ILP revenues remained stable at \$7.4 million; OCR staff assisted faculty in raising more than \$25 million in research funds.

Under the leadership of the President and Provost, MIT ambitiously pursued the creation of a small number of partnerships with key corporations. This year two new partnerships were created with the Merck Company and the Ford Motor Company. Merck agreed to invest \$3 million per year in research at MIT, with Professor Phillip Sharp as the principal faculty member. The Ford-MIT relationship involved well over a dozen MIT faculty, led by Professor Daniel Roos, to develop different aspects of the overall agreement. Ford agreed to invest significantly in new programs with MIT, including programs in environmental studies, virtual engineering, new automotive electrical systems, and the creation of new styles of life-long learning. A number of more modest corporate agreements were also reached this year, including a three-year \$1.2 million agreement with Repsol S.A., new pledges for the Epoch Fund, and a minority leadership grant from General Electric. Other corporate partnerships are in the proposal or early discussion stage.

OCR supported the faculty to help create several new international programs during the past academic year. New programs were launched in Thailand, Malaysia, and Singapore, including a new Professorship in the name of King Bhumibol of Thailand. Further programs in Singapore and Taiwan are also under active consideration. Existing programs in Argentina and Spain continue. Such programs typically focus on building institutions to improve a nation's capacity to provide advanced technological and management education for its citizens. Together, these programs will bring close to \$10 million per year in new revenues to MIT.

This past year the Center for Innovation in Product Development was established and enrolled five corporate members, the World Wide Web Consortium grew significantly, and new Media Lab initiatives (Digital Life, Things That Think) continued to attract significant corporate interest.

Mr. Bruce Anderson became the new Director of the Industrial Liaison Program (ILP) in January 1997. While membership remained stable in the US and Europe, ILP membership grew in Asia with the addition of the first ILP members from Singapore and India, and the addition of three new members in Thailand. Revenues from ILP member fees grew modestly to \$7.4 million, largely due to the success of new membership solicitations in the previous year.

Many innovative new information products and services have been created for ILP members. In May Corporate Relations offered a new product, Corporate ACCESS, to provide companies limited access to a subset of the services provided to ILP members. Two companies have thus far subscribed to Corporate ACCESS. An enhanced Web site (<http://ilp.mit.edu/>) now includes a new database of faculty expertise and research interests. Information spotlights include hot research topics, an electronically distributed compendium of "MITbits," and the Infinite Corridor series of videotaped lectures to provide exposure to MIT intellectual assets. The ILP's Annual Research Directors Conference attracted over 500 corporate leaders to campus in April.

In November, the MIT-ILP Japan Office celebrated its 20th anniversary with a colloquium for Japanese industry. While a number of senior faculty covered topics from economics to interactive media, the event also included discussions by video conference from MIT and California with an interactive question and answer session.

More information about the Office of Corporate Relations/ILP can be found on the World Wide Web at the following URL: <http://ilp.mit.edu/>

Thomas R. Moebus

ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT

The continued success of the Alumni Association activities is due to the partnership of first rate volunteers and an exceptional staff. The Alumni Fund eclipsed its 1996 record by achieving \$26.6 million with a slight increase in donors as well. This record was in excess of FY96 by \$1.8 million. We also achieved record breaking reunion gifts at the 25th, 40th and 50th reunions. Our successful activity included the visit by DuWayne Peterson '55 and his wife Nancy to Asian MIT clubs, a first for an Association president. DuWayne and Nancy gave unstintingly of their time and energy to 14 MIT club locations world wide with DuWayne adding two more solo trips. We went live with Alumni Network Services first product, Email Forwarding for Life (EFL) and by June had over 6500 alumni signed on. Technology Day was a smashing success and featured the Technology at Play: The World of Sports, Games, and Toys. We aided the Institute's presidentially appointed Task Force on Student Life and Learning with alumni survey results, major alumni leadership workshops and supported faculty travel for alumni feedback. *MIT's Technology Review* had a remarkable yet challenging year. We more than doubled advertising revenue, trimmed the budget to fit our resources, including some painful layoffs, lost our Editor-in-Chief and yet continue to produce an outstanding publication.

President Peterson continued the practice of a presidential column in *MIT's Technology Review*. He led the Board and provided marvelous counsel to the Executive Vice President and other senior staff. Brian Hughes '77 chaired the Alumni Fund Board to its new record. Chris Matthew '43 generously chaired the Technology Review Board and as ever lent his wisdom, integrity and personal force to a challenging year. Whenever Chris serves, MIT benefits. Chuck and Becky Vest continue their deep commitments to MIT and our alumni body. We are all strengthened by their generous example. This year alone they added yet another student centered alumni sponsored activity to their daunting round of alumni events. International visits included the first ever by an Association officer to Kuala Lumpur our newest organization the MIT Club of Malaysia.

An integrated staff executed a full array of programs intended to carry out the Association's mission of fostering alumni to alumni ties while increasing support of the Institute. Details of these Association programs are included below.

ALUMNI FUND

Under the leadership of Brian G. R. Hughes '77, the Alumni Fund set new records in dollars raised and alumni contributions. The \$26.6 million raised surpassed the old record set last year by \$1.8 million. Moreover, the number of donors -- 30, 577 -- set a record as well and represented the fourth consecutive year of increased donors. There was significant gift upgrading at selected target levels of \$5,000, \$2,000, and \$500 and overall a new record 55% of alumni donors made a gift of \$100 or more, a one year gain of 4%.

In 1993, following completion of MIT's *Campaign for the future*, the Alumni Fund Board established a five year plan to increase the Fund by an annual growth rate of 6.5%. The goal of this endeavor was to achieve a five year cumulative Alumni Fund total in the range of \$115-120 million. With the exceptional results of the past two years, the 1993-7 five year cumulative total achieved the \$115 million goal. This was an extraordinary achievement given that the Alumni Fund experienced two rather weak years in that period.

In 1997, gifts from the Classes of 1947, 1957 and 1972 broke all records for the respective 50th, 40th, and 25th reunion gifts. Overall, on Technology Day 1997, a total of \$56.5 million was reported in gifts by the 13 reunion classes and the senior class of 1997.

There was a special fund-raising appeal this year to honor Paul E. Gray '54 on the occasion of his stepping down as chairman of the MIT Corporation. Over the period of a few months, alumni and friends contributed more than \$2.3 million in gifts and pledges to establish the Paul E. Gray '54 Endowed Undergraduate Research Opportunities Fund (UROP), a spectacular achievement.

In its goal setting exercises, the Alumni Fund Board establishes separate objectives for undergraduate alumni and graduate alumni. This year, undergraduate alumni achieved a 44% participation rate with 57% making a contribution of \$100 or more. Graduate alumni achieved a median gift of \$100 for the first time, while the number of donors increased for the seventh consecutive year, achieving a participation rate of 31%.

Non-alumni parents continued in their support of MIT with close to 600 parents contributing nearly \$400,000 in gifts credited to the Alumni Fund.

The success of the Alumni Fund is due in large measure to the volunteer efforts of several thousand alumni, students and parents who each year offer their time in service to MIT. This service encompasses the full range of alumni activities including fund-raising, student recruitment, regional club leadership, and a myriad of others. Each year, several hundred alumni participate as leaders of the Association's national boards and MIT's Visiting Committees. The consistent outstanding results of the Alumni Fund in recent years offer testimony to the positive feelings held by MIT graduates for their alma mater.

CLASS PROGRAMS

Class Programs continued to provide strong support for undergraduate alumni through class fundraising and events. Nearly 400 volunteers worked with the staff to raise a record total in reunion gifts, plan and execute strong reunions, and plan an intellectually stimulating Technology Day.

Record reunion gifts were announced for the three major reunion classes: \$11.8 million from the Class of 1947; \$25.2 million from the class of 1957; and \$3.7 million from the Class of 1972. These accomplishments were possible due to the efforts of many volunteers, donors, and staff.

Other reunion gifts were also strong. Marked increases in the number of donors at various target gift levels are indicators of the success of these efforts. All told, reunion gifts totaling \$56.5 million were announced on Technology Day.

Undergraduate giving overall maintained a steady rate of 44% with 57% of donors giving at the level of \$100 or more. A very successful senior gift drive ensures that the newest class, the Class of 1997, will start with an impressive participation rate.

For the first time, the Alumni Association staff served as advisors to the senior class for Senior Week. Senior Week events included a variety of events both on- and off-campus and involved 20% of the senior class. In addition, the Alumni Association continued its long tradition of inviting seniors to dinner at the President's House. President and Mrs. Vest graciously hosted 555 students who were also welcomed by 41 alumni. These efforts, combined with the senior gift and class elections support, serve to help students make a transition from being students to being alumni and to involve and train a new cadre of alumni volunteers.

GEOGRAPHIC PROGRAMS

Geographic Programs integrates activities and services where alumni live. During FY97-92 clubs worldwide provided programs for alumni including a convocation in Switzerland for all European alumni; visits by President Vest with MIT alumni in France, the Delaware Valley, Palm Beach and Sarasota; and presentations by members of the Task Force on Student Life and Learning in Oregon, Northern California, Austin, Japan and Hong Kong.

In the first year of the Speakers Bureau, part of our new Alumni Continuing Education Program, 75 alumni and faculty speakers agreed to address 52 alumni clubs, participate in some of the 30 Travel Program excursions, and teach in the new MIT on the Road programs which will be launched in FY98. The Institute Career Assistance Network (ICAN), part of the Alumni Career Assistance Program, made over 750 matches with alumni mentors. The Graduate Alumni Program sponsored jointly with MIT departments nine professional association events.

Geographic Programs fundraising activities included, for the seventh consecutive year, increases in support from graduate only alumni raising nearly \$5 million from more than 11,000 donors. Donor acquisition telethons conducted by trained student callers continued strong with increases in the average gift from \$13 to \$81. Geographically based telethons were hosted and staffed by 135 alumni volunteers in five cities for pledges of \$300,000 from 1650 donors. Three planned giving luncheons were held in conjunction with the Office of Individual Giving reaching 34 interested alumni.

Also supported by staff in Geographic Programs are Association sponsored affinity groups. Highlights for these groups in FY97 include an increase to 600 members for the Association of MIT Alumnae (AMITA); the formation of the Arab Alumni of MIT (AAMIT); in the Black Alumni of MIT (BAMIT), the election of a new volunteer board, a professional development program for current students and alumni, and a successful fundraising effort; diverse events sponsored by Chinese Alumni of MIT (CAMIT) including the Annual Lunar New Year's celebration and a community service project which raised \$10,000 with other Asian alumni groups in New York City; and from the Bisexual, Gay and Lesbian Alumni group (BGALA), an IAP panel on gays in the workplace, a Tech Week reception and organizational meeting, and the presentation of a substantial alumni gift to establish the Bisexual, Gay and Lesbian Alumni Fund.

TECH WEEK AND REUNIONS

Alumni week, known as Tech Week, was combined with Commencement for the second year. Many of the logistical problems of the first year had been eliminated and 2700 alumni and guests returned to MIT to participate in over 90 different events organized for 14 classes and local alumni. Two returning members of the Class of 1922, Yardley Chittick and Marjorie Pierce, celebrated their 75th reunion.

Technology Day, entitled "Technology at Play: The World of Sports, Games, and Toys" featured MIT faculty members Woodie Flowers ME '73, Seymour Papert, Ed Crawley '76 AA, and Professor Steven Jacobsen ME '73 from the University of Utah. A new initiative, the Technology at Play Expo, exhibited sports, games, and toy-related products designed or developed by MIT alumni and faculty. Afternoon panel sessions focused on the limits of human performance, new technology and the economic and social implications of sports. Linda Sharpe '69 served as the chair of the Technology Day Committee and Woodie Flowers provided advice and inspiration as the faculty advisor to the committee.

The central events of Tech Week—Tech Night at Pops, the involvement of the 25th and 50th reunion classes in Commencement, a welcoming reception for new graduates, the events of Technology Day and the Tech Challenge Games—were well attended and served as a wonderful touchstone for alumni returning to campus for reunions. The Class Programs staff also implemented a new event for all classes, the Reunion Row, which brought a number of alumni back specifically to row on the Charles. The event was an unqualified success and will become a regular component of future Tech Weeks. More children accompanied parents this year to participate in Camp Tech, the program planned by the staff to provide interesting experiences for children while their parents attend Tech Week events.

At the end of FY97, the staffing of these programs was slightly changed to provide efficient services to all undergraduate classes. With the addition of program support for senior activities and the youngest 10 alumni classes into one comprehensive staff unit, the Class Programs staff hopes to further integrate activities among students, alumni, and MIT.

ALUMNI LEADERSHIP CONFERENCE

The annual Alumni Leadership Conference, attended by nearly 400 alumni and their guests, was held September 20-22, 1996. The Saturday morning program, "The Learning Community: Integrating Student Life and Learning at MIT," was introduced by Association President DuWayne J. Peterson '55 who is also chair of the Corporation Visiting Committee on Student Affairs. After remarks by MIT President Vest, Rosalind H. Williams, Dean for Undergraduate Education, moderated presentations by the following panelists: Paul E. Gray '54, Chair, MIT Corporation; R. John Hansman, Jr. PH'82, Professor, Aeronautics and Astronautics and Co-Chair, Presidential Task Force on Student Life and Learning; David A. Mindell HU'96, Dibner Professor, Science, Technology and Society; and Robert J. Silbey, Professor, Chemistry, Co-Chair, Presidential Task Force on Student Life and Learning.

After the awards luncheon, breakout sessions were led by members of the Task Force on Student Life and Learning in which alumni were asked to give feedback on issues the task force should take under consideration. Workshops were held on Friday for club officers, Educational Council members, Alumni Fund solicitors, and student leaders attending the conference. Sunday events included sessions with class secretaries and with international club officers.

ALUMNI/ NETWORK SERVICES

During the academic year 1995-96, the Association launched a new Internet based venture with the report of its Committee on Alumni Online Services in June of that year. A permanent director, Margaret Bruzelius, was hired and a search was begun for a webmaster to develop programs in this service. The first ANS product, Email Forwarding for Life (EFL), was introduced in February 1997 and by June 6,500 alumni had registered for the service, including nearly 1000 newly graduated alumni. ANS offers the Institute a gateway through which various Institute offices may offer services to registered alumni.

Under development at year end are an online alumni directory and conferencing services, slated for availability early in FY'98. Partnerships are being investigated with the MIT Libraries, CAES, faculty and students, the Office of the Dean for Undergraduate Education, and other offices at MIT.

PARENTS PROGRAM

The Association conducted the annual Family Weekend October 4-5, 1996. This successful program continues to attract more than 1800 members of MIT families to participate in MIT classes, tour MIT laboratories, question the deans and listen to performances of MIT student groups. Other activities of the Parents Association include publication of Parents News and solicitation of parent gifts to the Parents Fund which this year exceeded \$550,000 in gifts from nearly 600 non-alumni parents, of which nearly \$400,000 was reported in the Alumni Fund.

ALUMNI INFORMATION SERVICES

Continued progress was made toward implementation of the Association's new client/server computer system during FY'97, with the AIS staff completing its migration from a Macintosh to a Windows platform. This switch in operating systems will facilitate the AIS staff in its role as the primary testing ground for the new client/server system. As the launch date for this system approaches (March 1998), the AIS programming staff continues to receive the training; i.e., Powerbuilder, Oracle, etc., necessary to support development and maintenance of the new system.

Additionally, documentation of policies and procedures and the creation of an internal training program have begun in order to facilitate the conversion to our new environment. Work continues on a new events management system which will be fully operative sometime after the client/server "goes live."

Finally, the ongoing goal of "enhanced customer service" was addressed in FY'97 by successfully focusing on the improvement, enhancement, and careful documentation of the Alumni Association's email list service for alumni.

MIT'S TECHNOLOGY REVIEW

For the first time in *MIT's Technology Review's* history, the magazine has adopted a preliminary five-year business plan, unanimously endorsed by the Technology Review Board and Alumni Association Board of Directors. The magazine is now poised for growth. New benchmarks have been established -- a doubling of the magazine's circulation from the current 92,000 to over 200,000 -- as well as doubling of impact and recognition among the public-at-large through an aggressive sales campaign and newsstand sales.

The business plan calls for a positive revenue stream, driven by new growth in circulation among non-alumni readers, and the resulting increase in advertising revenue. This growth began in 1997 with a doubling of advertising revenue and a solidifying of the circulation revenue base.

Adopted as part of this growth plan is a focus on re-aligning of the look and editorial content, as well as a strengthening of the MIT relationship. Initial strides have already been made through a logo change made in the February 1997 issue to read "*MIT's Technology Review*". The logo change has been very well received by current readers, and the design and editorial staff are undertaking an exhaustive review of the magazine.

MIT's Technology Review's editor resigned in the Spring. An editorial search committee, a subset of the Technology Review Board, is in the final stages of recruiting a new Editor-in-Chief, to be at the editorial helm by Fall of 1997.

MIT's Technology Review also has had significant success containing its costs this year. Production costs have been reduced through two new contracts negotiated with the magazine's printing and circulation vendors. To further contain costs, a reduction in force plan was implemented resulting in the elimination of three positions. All efforts have successfully focused on constructive repositioning for growth.

MIT ENTERPRISE FORUM

In January Edmund M. Dunn ML'73 joined the Forum as Executive Director. A chapter chairs' meeting was held in Oxnard, CA in April to learn about the concerns of the chairs, to learn about effective chapter practices, and to discuss the Forum's changing emphasis to bring chapters into closer contact with the Institute.

To further this objective in June 26th, the Forum presented the second in a series of satellite broadcast programs designed to provide useful information to entrepreneurs and business professionals. Bob Metcalfe '68, incoming Association president, conducted a lively presentation titled "Internet Futures" with 450 attendees in Kresge auditorium and an additional 600 in chapters in Hartford, New York City, Toronto and Washington D. C. and the MIT Club of Northern California. The director of MIT's Lab for Computer Science, Michael Dertouzos EE'64, provided opening remarks and moderated the Q&A portion of the evening. Following the broadcast about one hundred requests for copies of the text have been received.

PERSONNEL

Matters of personnel continued at their usual pace, with a spike in the summer months of 1996, when a record number of open positions were filled with a record number of first-rate staff members. Edmund M. Dunn ML '73 was named Director of the MIT Enterprise Forum in January, and has already accomplished a major satellite broadcast event featuring incoming Association President Robert M. Metcalfe '68. The Geographic Programs group was enhanced with the hiring of a number of Alumni Affairs Officers in the areas of club support and departmental relations, including Heidi Ganss, Kevin Holland, Christine Tempesta, and Angela Um. A new Manager of the Data Entry group was found in Jean Connolly, and the brand new Alumni Network Services effort attracted its first Director in Margaret Bruzelius. Jill Pullen moved from the office of the Dean of Students to join our Student Programs contingent.

Departures in the year included Steve Marcus, Editor in Chief of *MIT's Technology Review*, who left to explore new writing opportunities, hoping especially to complete a book. A search committee is well on its way to finding a replacement to fill this important post. All told, there were 18 departures, and the same number of new hires, during a year in which still more records in the fundraising arena were logged, and in which *MIT's Technology Review* began to successfully explore redesign possibilities. There were also 10 promotions, as the Association continued to grow and develop its best staff.

AWARDS

Honorary Memberships were presented at the Technology Day luncheon on June 8, 1996. All other awards were presented at the awards luncheon of the Alumni Leadership Conference on September 21.

Bronze Beaver: Mr. Glen V. Dorflinger '46, Mr. L. Robert Johnson '63, Mr. John A. Morefield '56, Mr. R. Gregory Turner '74

Harold E. Lobdell '17 Distinguished Service Award: Ms. Lois J. Champy AR'71, Dr. Eva Krug LI, Dr. Roseanna H. Means '76, Ms. Linda C. Sharpe '69, Mr. Charles O. Staples '59

George B. Morgan '20 Award: Mr. Bruce Anderson '63, Dr. Lisa C. Klein '73, Mr. Jay W. Van Dwingelen '74

Henry B. Kane '24 Award: Mr. Theodore P. Heuchling '46, Mr. James A. Lash '66, Mr. William E. Murray Jr. '67, Mr. Martin H. Schrage '63

Presidential Citation Award: Class of 1995 (Senior Gift Committee), Class of 1975 20th Reunion Gift Committee, Class of 1970 (25th Reunion), BAMIT-McNair Development Committee (Ronald E. McNair PH'77 Scholarship Fund), MIT Club of Germany

Honorary Membership: Mr. Harold "Hatch" Brown Jr., Professor Phillip A. Sharp

William J. Hecht

INDEX

A

| | |
|---------------------------------------------------------------|-----|
| Academic Computing Practice..... | 493 |
| Administration and Services, Sloan School of Management..... | 397 |
| Admissions Office..... | 92 |
| Advanced Educational Services, Center for..... | 48 |
| Advanced Visual Studies, Center for..... | 220 |
| Aeronautics and Astronautics, Department of..... | 234 |
| Aga Khan Program for Islamic Architecture..... | 221 |
| Alumni and Alumnae of MIT, Association of..... | 507 |
| Anthropology..... | 356 |
| Archaeological Materials, Center for..... | 55 |
| Architecture and Planning, School of..... | 206 |
| Architecture, Department of..... | 209 |
| Artificial Intelligence Laboratory..... | 290 |
| Arts, Office of the..... | 76 |
| Associate Provost..... | 63 |
| Associate Provost for the Arts..... | 68 |
| Athletics, Physical Education, and Recreation Department..... | 102 |
| Audio Visual Services..... | 453 |
| Audit Division..... | 466 |

B

| | |
|--------------------------------------------------|-----|
| Benefits Administration..... | 487 |
| Benefits and Systems..... | 486 |
| Biology, Department of..... | 405 |
| Biomedical Engineering, Center for..... | 124 |
| Biotechnology Process Engineering Center..... | 292 |
| Brain and Cognitive Sciences, Department of..... | 408 |
| Budget and Financial Planning, Office of..... | 469 |
| Bursar's Office..... | 84 |

C

| | |
|--------------------------------------------------------------------------------|-----|
| Campus Activities Complex..... | 99 |
| Campus Police..... | 454 |
| Cancer Research, Center for..... | 437 |
| Career Services and Preprofessional Advising..... | 94 |
| Chair of the Faculty..... | 441 |
| Chemical Engineering, Department of..... | 244 |
| Chemistry, Department of..... | 411 |
| Civil and Environmental Engineering, Department of..... | 251 |
| Clinical Research Center..... | 138 |
| Collection Services..... | 194 |
| Communications and Donor Relations, Office of..... | 503 |
| Comparative Medicine, Division of..... | 128 |
| Compensation..... | 486 |
| Computer Science, Laboratory for..... | 311 |
| Concentrations in All Fields of the Humanities, Arts, and Social Sciences..... | 350 |
| Concourse..... | 307 |
| Controller's Accounting Office..... | 467 |
| Copy Technology Centers..... | 455 |
| Corporate Relations, Office of..... | 505 |
| Corporation, Secretary of the..... | 463 |
| Council on Primary and Secondary Education..... | 56 |
| Counseling and Support Services..... | 96 |

D

| | |
|----------------------------------------------------------------------------------|-----|
| Degrees Awarded in September 1996, February 1997, and June 1997, Number of | 113 |
| Development Research and Systems, Office of | 504 |
| Disability/Accessibility Services | 483 |

E

| | |
|--------------------------------------------------------------------|-----|
| Earth, Atmospheric, and Planetary Sciences, Department of | 413 |
| Economics, Department of | 353 |
| Education, Sloan School of Management | 388 |
| Educational Opportunity Programs, Office of | 60 |
| Electrical Engineering and Computer Science, Department of | 257 |
| Electromagnetic and Electronic Systems, Laboratory for | 314 |
| Employee Relations | 484 |
| Endicott House | 456 |
| Energy Laboratory | 149 |
| Engineering, School of | 231 |
| Enrollment in Humanities, Arts, and Social Sciences Subjects | 349 |
| Environmental Education and Research, Program in | 334 |
| Environmental Health Sciences, Center for | 125 |
| Experimental Study Group | 432 |

F

| | |
|-----------------------------------------------------------------------|-----|
| Facilities Use Committee | 59 |
| Faculty and Academic Staff Count as of October 1996 | 490 |
| Faculty and Staff Information Services | 486 |
| Faculty, Chair of the | 441 |
| Family Resource Center | 488 |
| Finance and Treasurer, Vice President for | 466 |
| Foreign Languages and Literatures | 357 |
| Foundation Relations and School Development Services, Office of | 504 |
| Francis Bitter Magnet Laboratory | 154 |

G

| | |
|--------------------------------------------------------|-----|
| George R. Wallace, Jr. Astrophysical Observatory | 431 |
| George Russell Harrison Spectroscopy Laboratory | 428 |
| Graduate Education Office | 118 |
| Graduate Education, Dean for | 118 |
| Graduate Enrollment Fall 1997 | 121 |
| Graduate Students, HASS | 351 |

H

| | |
|-------------------------------------------------------------------------|-----|
| Harvard-MIT Division of Health Sciences and Technology | 132 |
| HASS Minor Applications for Classes of 1997, -98, -99, and 2000 | 352 |
| Humanities, Arts, and Social Science Office | 347 |
| Haystack Observatory | 159 |
| History | 360 |
| Human Resources and Equal Opportunity Officer, Vice President for | 475 |
| Human Resources Practices Design/Development Team | 484 |
| Humanities and Social Science, School of | 343 |
| Humanities, Department of | 356 |

I

| | |
|-------------------------------|-----|
| I/T Competency Groups | 500 |
| I/T Delivery Process | 496 |
| I/T Discovery Process | 495 |
| I/T Integration Process | 499 |
| I/T Service Process | 497 |
| I/T Support Process | 498 |
| In Special Recognition | 16 |

| | |
|---------------------------------------------------------------------------------|-----|
| Individual Giving, Office of..... | 502 |
| Industrial Liaison Program..... | 505 |
| Industrial Performance Center | 308 |
| Information and Decision Systems, Laboratory for | 319 |
| Information Systems, Vice President for | 492 |
| Innovation in Product Development, Center for | 297 |
| Insurance and Legal Affairs | 457 |
| Integrated Studies Program | 310 |
| International Studies, Center for | 377 |
| L | |
| Labor Relations | 485 |
| Leaders for Manufacturing Program | 389 |
| Learning and Memory, Center for | 426 |
| Libraries | 189 |
| Lincoln Fiscal Office | 468 |
| Lincoln Laboratory..... | 199 |
| Linguistics and Philosophy, Department of | 367 |
| List Visual Arts Center..... | 70 |
| Literature | 362 |
| M | |
| Manufacturing and Productivity, Laboratory for | 325 |
| Materials Processing Center..... | 327 |
| Materials Research in Archaeology and Ethnology, Center for..... | 55 |
| Materials Science and Engineering, Center for..... | 144 |
| Materials Science and Engineering, Department of..... | 262 |
| Mathematics, Department of | 418 |
| Mechanical Engineering, Department of | 273 |
| Media Arts and Sciences, Program in | 213 |
| Media Laboratory..... | 226 |
| Medical Department..... | 476 |
| Microsystems Technology Laboratories | 332 |
| MIT Card, Housing and Food Services | 103 |
| MIT Museum | 72 |
| MIT Press..... | 471 |
| MIT/Woods Hole Joint Program in Oceanography and Oceanographic Engineering..... | 142 |
| Museum Loan Network Program..... | 75 |
| Music and Theater Arts | 364 |
| N | |
| Nuclear Engineering, Department of | 278 |
| Nuclear Reactor Laboratory | 163 |
| Nuclear Science, Laboratory for | 434 |
| Number of Degrees Awarded in September 1996, February 1997, and June 1997..... | 113 |
| Number of Students by Course and Year..... | 111 |
| Number of Women Students by Course and Year | 116 |
| O | |
| Ocean Engineering, Department of..... | 284 |
| Office Computing Practice..... | 494 |
| Office of Minority Education..... | 97 |
| Office of the Controller | 467 |
| Operations Research Center | 167 |
| Operations, Senior Vice President | 452 |
| P | |
| Personnel Changes | 24 |
| Personnel Services | 484 |

| | |
|---------------------------------------------------------------------|-----|
| Physical Plant | 458 |
| Physics, Department of | 420 |
| Planning Office | 460 |
| Plasma Science and Fusion Center..... | 170 |
| Political Science, Department of..... | 369 |
| Polymer Science and Technology, Program in | 338 |
| President..... | 7 |
| Principal Gifts, Office of..... | 503 |
| Property Office..... | 468 |
| Provost | 46 |
| Public Relations Services..... | 39 |
| Public Services..... | 192 |
| Purchasing | 461 |
| R | |
| Real Estate, Center for | 224 |
| Registrar's Office..... | 85 |
| Research Centers and Groups, Sloan School of Management..... | 393 |
| Research Laboratory of Electronics | 178 |
| Research, Vice President for and Graduate Education, Dean for | 118 |
| Residence and Campus Activities | 108 |
| Resource Development, Vice President for | 502 |
| ROTC Programs..... | 105 |
| S | |
| Safety Office | 462 |
| Science, School of | 403 |
| Science, Technology, and Society, Program in..... | 373 |
| Sea Grant College Program..... | 182 |
| Secretary of the Corporation | 463 |
| Senior Vice President, Operations | 452 |
| Sloan School of Management | 387 |
| Space Research, Center for | 439 |
| Sponsored Programs, Office of | 469 |
| Statistics for the Year | 21 |
| Students by Course and Year, Number of..... | 111 |
| Student Financial Aid..... | 86 |
| Student Information Systems | 88 |
| System Design and Management Program | 339 |
| T | |
| Technology and Development Program..... | 187 |
| Technology and Policy Program | 340 |
| Technology Licensing Office..... | 143 |
| Technology Planning and Administration | 197 |
| Technology, Management and Policy Program | 341 |
| Technology, Policy, and Industrial Development, Center for | 298 |
| Toxicology Division of | 129 |
| Training and Development Programs | 482 |
| Transportation Studies, Center for | 303 |
| Treasurer, Vice President for Finance and..... | 466 |
| U | |
| Undergraduate Academic Affairs..... | 89 |
| Undergraduate Education and Student Affairs, Dean for | 82 |
| Undergraduate Majors, HASS | 351 |
| Urban Studies and Planning, Department of..... | 215 |

V

Voice, Data, and Image Networking Practice 494

W

Whitaker College of Health Sciences and Technology..... 122

Women, Foreign National and Minority Graduate Enrollment, AY 1973 to AY 1997..... 120

Women Students by Course and Year, Number of 116

Women's Studies Program..... 383

Writing and Humanistic Studies, Program in..... 366