

CARBON SOCCER BALLS—Recently MIT researchers led by Professor Jack Howard of chemical engineering (left) announced a new way to produce fullerenes, ball-shaped forms of carbon with possible applications in superconductivity, cancer therapy, and more. Here Professor Howard and graduate student Christopher Pope (right) sit behind models of fullerene molecules Mr. Pope constructed. The model in the foreground represents buckminsterfullerene, named for the great architect/engineer/inventor whose geodesic domes it resembles. **Photo by Donna Coveney**

UP IN FLAMES

Team Finds New Way To Create Fullerenes

■ **By Elizabeth A. Thomson**
News Office

Applying the results of years of research on soot formation in flames, MIT scientists have found a new way to produce fullerenes—ball-shaped forms of carbon discovered in 1985 that have rocked the scientific world with possible applications in superconductivity, catalysis, cancer therapy and more.

The MIT technique is based on a combustion process already used in industry, so the scientists predict that it could be scaled up to produce large quantities of fullerenes—better known as buckyballs—fairly easily. At present the roughly spherical molecules can only be produced in gram amounts.

In addition, the MIT group says their technique can be adjusted to produce more of one fullerene over another. That could prove important should a given application require a specific fullerene.

"This is one of the most exciting projects that's come along to us in some while," said Jack Howard, professor of chemical engineering and principal researcher for the work, which was reported in the July 11 issue of *Nature*.

The story begins in 1985 when Rice University scientists discovered buckminsterfullerene, a new form of carbon whose 60 atoms form a structure like one of the geodesic domes Buckminster Fuller invented. Until

then, only two other forms of carbon were known: diamond and graphite.

"It's very surprising that after well over a century of research on carbon, we would only now be finding a new form," Professor Howard said.

Scientists soon found another fullerene containing 70 carbon atoms. While buckminsterfullerene, or C_{60} , resembles a soccer ball, C_{70} forms a shape that's more oblong—like a rugby ball. The search was on to learn more about the molecules. What are their properties? Can we find others? How do they form?

Howard and colleagues were interested from the start. For years they had studied the formation in flames of soot, the small carbon-containing particles that give flames their yellow color. And early reports on fullerenes speculated that the molecules might be related to soot, possibly even being soot particles at an early stage of development.

Such suggestions, however, appeared to be in conflict with the great differences between fullerenes and soot, so the MIT group pursued an alternative concept: that fullerenes and soot might be formed along parallel but significantly different routes.

To that end Tom McKinnon, then a graduate student in chemical engineering, performed several analyses on small samples of material collected with a probe from sooting flames. Christopher Pope, also a graduate stu-

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UP TO \$27M

Magnet Lab Funded for 4 More Years

MIT welcomed the news earlier this month that its Francis Bitter National Magnet Laboratory (FBNML) is expected to receive \$27 million over the next four years.

"With these funds, the Magnet Lab will continue to be a center for high field research and technology for the next four years," said Professor of Physics J. David Litster, director of the FBNML. The laboratory's future after September 30, 1991, had been in question since a year ago when the National Science Foundation decided that a new National High Magnetic Field Labora-

tory (NHMFL) would be based at Florida State University rather than at MIT.

The National Science Foundation (NSF) announced yesterday that its National Science Board on August 9 approved an NSF recommendation to provide up to \$23 million to MIT "to continue the support of the Francis Bitter National Magnet Laboratory through September 1995. At that time, the new high magnetic field laboratory currently being constructed with NSF funds is expected to become fully operational," the NSF announcement said.

In a joint project, the NHMFL at Florida State is to provide \$4 million, in funds authorized to it by the NSF, to push the technology further and help MIT design and build a \$9 million, world-record 45 tesla class magnet for later use in the Florida laboratory. The other \$18 million will fund four years of operations, providing facilities for the nation's scientists to use the 25 magnets at the MIT lab in their experiments. Each year, 300 to 400 scientists from universities and laboratories throughout the nation use the MIT magnets, which range in strength from 8 to more than 30 tesla. (One tesla equals a magnetic field 20,000 times the strength of the Earth's magnetic field.)

Professor Litster commented: "This arrangement represents a cooperative effort of the National Science Foundation, the Francis Bitter National Magnet Laboratory and the National High Magnetic Field Laboratory to provide the best possible support for high magnetic field research in the United States. We are looking forward to providing users with high magnetic fields for the next four years, and we are looking forward to the cooperative project with the NHMFL to produce a 45 tesla class magnet. This will maintain the US world leadership."

The current world record for a steady magnetic field is held by the MIT laboratory for a 31.8 tesla magnet, which has been in service since 1981. That record will be superseded this fall when the MIT lab puts into service a new 35 tesla magnet. Magnetic fields are used by scientists to examine the nature of materials in the fields of physics, materials science and engineering, chemistry, biological sciences, and computer science.

The proposed 45 tesla magnet, by combining superconducting magnets (continued on page 5)

MODERNIZATION

New Building Planned For Lincoln Laboratory

Construction is expected to begin in September on a major research facility at Lincoln Laboratory, the federally funded research and development center in Lexington that MIT operates for the government. The research facility will be located on land that MIT has leased from the federal government.

The work is part of a modernization and consolidation program that MIT is undertaking with an eye toward the future of the 40-year-old facility, located at Hanscom Air Force Base. Included will be the key facility, a 490,000-square-foot building called the South Laboratory, and a 1,000-space multi-level garage. Significant savings for the government in lease, transportation and communication costs are expected.

Spaulding and Slye, which is responsible for all aspects of the project's

development, said the construction cost will be \$70 million. Spaulding and Slye will build the structure to MIT's specifications and will lease the building to MIT. Spaulding and Slye has retained Jung/Brannen Associates, Inc., as master-plan architect and Perini Corp. as the general construction contractor. The target completion date for the construction is the summer of 1994.

Lincoln Laboratory has been part of MIT since 1951, when it was created at the request of the federal government to undertake the research and development of the North American Air Defense System. When that mission ended in the late 1950s, the laboratory turned to research in electronics, communications, strategic defense and surveillance. The laboratory is unrivaled in the development and applica-

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WELCOME CLASS OF '95

New Students Arrive on Campus

■ **By Joanne Miller**
News Office

A trickle of new students began arriving on campus last week. Beginning tomorrow they will arrive in torrential numbers for a ten-day Residence/Orientation (R/O) program packed with activities and tours.

R/O has two major components—residence selection and academic orientation—of roughly equal length. Activities will be launched Thursday, Aug. 29, at 4pm with welcoming remarks from President Charles M. Vest followed by Project MOYA (Move Off Your Assumptions), an activity designed to help new students get acquainted.

Over 100 faculty and staff members and upperclass students have been trained to be MOYA leaders to direct team puzzles and physical activities that will engage the new students in learning something about their classmates, MIT, R/O and even themselves. Though most of Project MOYA will take place Thursday evening, it will conclude with a surprise finale for everyone at the Freshman Picnic Friday at 1pm. After the picnic the freshmen will begin visiting dormitories and independent living groups to select where they will live.

Academic orientation will begin with a breakfast—new this year—for new students, faculty and student-oriented staff members Wednesday, Sept. 4, on

Kresge Oval. It will be followed by a presentation, "What is a Provost, Anyway?," in which Provost Mark Wrighton and some colleagues will offer an intriguing look at MIT education.

The Advisor/Advisee Picnic at which freshmen have their first con-

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Pollution To Be Workshop Focus

Members of the MIT community are invited to attend Preventing Pollution, a series of four workshops in September featuring case studies of prevention programs at The Robbins Company in Attleboro, Polaroid, and Procter and Gamble.

The goal of the series is to help participants learn how to prevent pollution in their own businesses or programs. As a result, the workshops are "interactive working meetings in which participants learn from one

another," according to the program brochure.

The workshops also offer a twist from traditional prevention programs, focusing on organizational behavior and management strategies rather than new technologies. "We feel [such strategies] are the keys to successful pollution prevention," said John Ehrenfeld, coordinator of the series, in a letter to MIT faculty, students and staff.

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IN BRIEF

SITTERS NEEDED

The MIT Women's League is looking for babysitters to tend the children of women attending the League's English Conversation Classes beginning Thursday, Sept. 19. Sitters are needed for 2 1/2 hours each Tuesday and Thursday morning (five hours a week). If you are interested, call Coordinator Keiko Kanda at 492-6324 or Pam Daveta at the League office, x3-3656.

FRIDAY DEADLINE

Friday, Aug. 30, is the deadline for enrollment in the fall term at the Lowell Institute School. Catalogs and applications are available in Rm E32-105 or by calling x3-4895.

BATES DIRECTOR

Moniz Is Appointed Physics Head

Professor Ernest J. Moniz, director of the Bates Linear Accelerator Center since 1983, has been named head of the Department of Physics, effective September 1.



Professor Moniz, a theoretical nuclear physicist, has gained wide recognition for his frontier work on the interaction of pions with nuclei. Pions are short-lived particles primarily responsible

for the nuclear force. Professor Moniz has been instrumental in developing what is widely considered to be the fundamental description of pion-nuclei interactions.

His appointment as department head was announced by Dean of Science Robert J. Birgeneau, who was head of physics when he was named dean earlier this year. Dr. Birgeneau is the Cecil and Ida Green Professor of Physics.

In making the announcement, Professor Birgeneau said that Professor Moniz combines outstanding research accomplishments with an excellent record of administration at Bates and a deep interest in education. Professor Moniz was enthusiastically recommended to the dean by the Physics Head Advisory Committee chaired by Professor Thomas J.

Greytak, Professor Birgeneau said.

At Bates, Professor Moniz has helped guide the development of the laboratory's research program toward coincidence experiments and fundamental measurements of the electromagnetic structure of "elementary" strongly interacting systems, both nuclei and their constituent particles. The laboratory, which serves the national community, also embarked on a major upgrade—the construction of a "stretcher/storage ring" 200-meters in circumference. The facility will produce high-intensity continuous electron beams, thereby providing unique research opportunities starting next year.

Professor Moniz, 46, received the BS in physics from Boston College (1966) and the PhD in theoretical physics from Stanford University (1971). He joined the MIT faculty in 1973 after two years as an NSF postdoctoral fellow at the Centre d'Etudes Nucleaires de Saclay and the University of Pennsylvania.

The physics department is one of the largest in the world and is at the forefront of physics research and education. Approximately 90 full-time faculty members teach the 250 undergraduate and 300 graduate students. The department provides education in all areas of both theoretical and experimental physics, including astrophysics, nuclear and particle physics, and atomic, plasma and condensed-matter physics.



WORM'S-EYE VIEW—Photojournalist Donna Coveney took this shot up through the atrium of the E,E&G Education Center in Building 34.

AT SLOAN

White Is Promoted

Dean Lester C. Thurow of the Sloan School of Management has announced the promotion of Alan F. White from associate dean to senior associate dean.



"This promotion is in recognition of the many years that Alan has spent leading our executive education programs, the talent he brings to external relations with companies' and

countries, and the entrepreneurship he brings to resource development," Dean Thurow said. "To build the best business school team in the country, a good faculty and good students are not enough. It is necessary to have the best talent at every position. Alan brings us that talent at his position."

Dean White received an AB from Miami University in 1965 and the SM from MIT in management in 1971.

He served as regional representative for the US Peace Corps Programs in the Philippines from 1963 to 1967, director of the University of Hawaii Center for Cross Cultural Training and Research from 1967 to 1970, and special assistant to the president of the University of Hawaii from 1971 to 1973.

He became associate director for executive programs at the Sloan School in 1973, director of executive education in 1975 and associate dean for executive education in 1985. He also has served as a lecturer since 1975.

He is chairman of the board of directors of the Consortium of University Executive Program Directors, and he serves as a consultant to organizations in the areas of human resource planning, education and training.

Lipsky on Leave at Ford Foundation

Dr. Michael Lipsky, professor of political science, has taken a leave of absence from MIT to serve as a program officer in The Ford Foundation's Governance and Public Policy Program. He will have responsibility for developing programs on democratic institutions and state and local government.

At MIT, Professor Lipsky has specialized in public policy, American

politics, and social movements. He served as a consultant to ACTION, the federal volunteer agency, in the 1970s, and more recently was a member of the Committee on the Status of Black Americans of the National Research Council. He has written extensively on protest and community organizations, public service delivery, and the relationship between government and the voluntary sector.

Hurricane Bob Inflicts Little Damage

A dozen windows were blown out and seven trees crashed to the ground at MIT during Hurricane Bob, causing only light damage, Thomas E. Shepherd Jr., associate director of Physical Plant, reported last week.

Extensive sandbagging at locations vulnerable to flooding from street runoff kept water damage very low. Mr. Shepherd said. Sandbags were placed at

several points, including West Garage, McGregor, Walker Memorial and the steep ramp behind Kresge Auditorium.

Pressure in the tennis bubble was increased to keep the structure from flapping in the wind and it survived without damage.

The Institute closed at 11am, but Physical Plant workers were on hand throughout the day, Mr. Shepherd said.

EMERITUS HONOR

Scrimshaw to Receive Food Prize

The World Food Prize for 1991—an international honor recognizing individual achievement in improving the quality, quantity or availability of food in the world—has been awarded to Dr. Nevin S. Scrimshaw, MIT Institute Professor Emeritus.



It is the first time in its five-year history that the prize, given for accomplishments in food and agriculture, is being awarded for

contributions in the area of nutrition. The previous laureates have been botanists or biologists cited for increasing the world's food supply.

Dr. Scrimshaw, who currently directs the Food, Nutrition and Human Development Program for the United Nations University of Tokyo and serves as a member of Harvard University's Center for Population Studies, will receive the prize in a ceremony in Des Moines, Iowa, on October 14. The prize includes a cash award of \$200,000 and

a sculpture by world-renowned designer Saul Bass.

John Ruan, chairman of The World Food Prize Foundation, said that while previous prize recipients had been honored for their contributions in the production of food, "we now acknowledge achievements in the area of nutrition."

"Dr. Scrimshaw's revolutionary accomplishments toward alleviating malnutrition in developing countries have made a substantial difference toward improving the lives of millions of people," Dr. Ruan said.

Dr. Scrimshaw, in a statement distributed by the foundation, said, "This award provides an opportunity to focus on the issue of world hunger. Despite significant scientific and medical advances, it is somewhat disheartening that global hunger continues to plague society."

Dr. Scrimshaw, who has both medical and PhD degrees, came to MIT in 1961 as professor of human nutrition and head of a new Department of Nutrition and Food Science. In 1976 he established the International Food and Nutrition Planning Program at MIT, which provided

training in nutrition research for scientists in developing countries. In 1980, as Institute Professor, he began research on the functional consequences of iron deficiency and developed methods for getting iron into the diets of people in underdeveloped countries. Today he remains one of the principal advisors to international and national organizations in the field of food and nutrition. He retired from MIT in 1988.

When Dr. Scrimshaw was named to receive the first James R. Killian Jr. Faculty Achievement Award in 1972, the selection committee said that he was "not only a researcher of extraordinary accomplishment, but also a distinguished administrator and teacher, a scientist whose career exemplifies the ideal of science as a search for human answers to the most basic of human needs."

Dr. Scrimshaw, who lives in New Hampshire and maintains an office in Cambridge, has received numerous awards, including one earlier in the summer, the 1990-91 Alan Shawn Feinstein Merit Award for Public Service.

INTERNATIONAL ACCESS

Thesis Abstracts Added to Database

In a change designed to increase access to MIT theses by scholars and researchers around the world, the MIT Libraries have begun submitting abstracts of MIT theses to an international database.

The database, Dissertation Abstracts International (DAI), is recognized as the most widely used information source about theses written in English. Further, because of its dissemination around the world DAI is important as a tool for researchers and as exposure for authors.

Until now the only comprehensive

index of MIT theses was the Libraries' catalogue, where search possibilities were limited to author or title. This made it difficult, especially for persons outside the Institute, to find out about theses written here if they did not have a specific citation. DAI will group abstracts by subject, and index them by keyword and author.

The Libraries' new CD-ROM based catalogue, to be added later this year, will allow keyword searching and other ways to find theses, but outside access will be more dramatically improved by adding the MIT abstracts to DAI.

Researchers interested in a particular MIT abstract in the database can request copies of the complete thesis from the Libraries' Microreproduction Laboratory. The Libraries hope to offset the cost of putting abstracts in DAI by retaining distribution rights of the thesis copies, rather than charging graduate students.

All doctoral-level theses have been included in DAI since the beginning of the 1990-91 academic year. DAI is published by University Microfilms Incorporated.

US V. MIT

Penn. Court Denies Motion to Move Suit

■ By Kenneth D. Campbell
News Office

A federal judge in Philadelphia has denied MIT's request to move the US v. MIT antitrust suit on financial aid to Boston.

US District Court Judge Louis C. Bechtel, chief judge of the US District Court for the Eastern District of Pennsylvania, filed his order August 7, according to court papers.

A spokesman for MIT said, "The reason MIT sought the transfer to Boston was to make the litigation less costly in terms of people's time and expense. However, the judge has made his decision and we go on from here."

Attorneys for MIT, appearing in court July 31, asked the judge to move the unprecedented antitrust case to the US District Court in Massachusetts, where the annual financial aid "overlap" meeting of 23 private colleges, including MIT and the eight Ivy League colleges, has taken place for more than two decades. The financial aid officers attending the professional meetings discussed the financial need of undergraduate students who had been admitted to more than one of the colleges and had applied for aid.

MIT declined to sign a May 22 consent decree to which the Ivy League colleges reluctantly agreed. The colleges said they did not believe they had violated the Sherman Antitrust Act but that the cost of fighting the US Department of Justice was prohibitive. The consent decree is subject to approval by the judge.

MIT maintains that its "actions in awarding financial aid based upon the demonstrated need of each applicant are consistent with and required by federal law." The Sherman Antitrust Act's strictures against private business competition do not apply to the competition among nonprofit private educational institutions and their decision as to who shall receive their charitable funds in the form of scholarships, MIT attorneys say.

"This is the first time in the 101-year history of the Sherman Antitrust Act that the Department of Justice has maintained that the antitrust law applies in full force to the administration of the basic educational mission of nonprofit educational institutions," said MIT's attorney, Thane D. Scott of the Boston firm of Palmer and Dodge.

The civil suit, in the opinion of Washington Post columnist Edwin M. Yoder Jr., "is perhaps the most overbearing move against private higher education in the nation's history." Yoder wrote, "It is wholly appropriate that colleges and universities guard their limited scholarship funds against bidding wars. It obviously means more aid for more students."

The consent decree would allow the Ivy League colleges to agree to administer aid based on financial need in the case of athletes, but bars such an agreement for other students.

The overlap meetings resulted in a

net increase of financial aid offered by MIT, according to MIT's Financial Aid Office.

MIT's brief said "The primary objective of Overlap is to make colleges more accessible for talented but economically disadvantaged students by encouraging the granting of financial aid on the basis of need."

"In this case, the government contends that the principles of fiscal prudence underlying the federal financial aid system are not just imprudent but also illegal when implemented by private colleges with respect to their own charitable funds," the MIT brief said.

The Justice Department case, entitled "United States v. Brown University et al.," also named as defendants Columbia, Cornell, Dartmouth, Harvard, MIT, Princeton, University of Pennsylvania and Yale.

The Justice Department brief opposing the motion to transfer the case to Massachusetts stated that the members of Overlap include the nine colleges mentioned, plus three other sets of colleges: Amherst, Bowdoin, Wesleyan and Williams; Barnard, Bryn Mawr, Mount Holyoke, Smith, Vassar and Wellesley; and Colby, Middlebury, Trinity and Tufts.

In a July 22 op-ed article in The New York Times, MIT Chairman Paul E. Gray said, "The issue is not price fixing. There is no personal gain or profit motive involved here. In fact, it is quite the reverse: the issue concerns the fair distribution of subsidies—generated largely from private, charitable donations—to help defray the cost of education for talented students whose families cannot afford it. The Attorney General's accusations flout the 1986 law, mandated by Congress, that requires schools to give Federal aid only to those who have demonstrated need."

Dr. Gray asked, "If the antitrust action prevails, what will the consequences be? Given that funds are limited, once colleges and universities are forbidden to agree on aid, some will choose to compete for students by offering them sums beyond their needs, thus reducing the amount available to other students. Admissions practices may change to give preference to students whose families can pay for college rather than those with the highest academic ability."

Dr. Gray, who was president of MIT from 1980 to 1990, noted that since the Justice Department investigation began three years ago, "MIT and some 60 other private colleges have spent more than \$10 million in legal fees to respond to these inquiries. These funds could have been used for scholarships."

"If successful, the government's antitrust action will result in financial competition for individual students that will, over time, drive up college costs. It will erode the principle of intellectual merit as the primary factor in admissions decisions and deny many the full measure of assistance they require to attend college," Dr. Gray wrote.



SMILE, EVERYONE—MIT was host to ten high school students as part of Cambridge TeenWork this summer. The students and coordinators of the program posed for their picture earlier this month. From left they are: Chris Papadopoulos (Personnel); Blanca Garcia (Medical Department); Eric Chesnakas (Personnel); Warren MacEachern, TeenWork Director; Sarah Eusden, MIT Government and Community Relations; Ginny McCabe, TeenWork counselor; Ilda Moura (Materials Processing Center); Lauren Gilman, program assistant; Fatema Khalifa (Personnel); Ron Suduiko, MIT Government and Community Relations, and Liz Mulcahy, assistant to the manager of Personnel Services. Several TeenWorkers were not present for the photo. Photo by Donna Coveney

MANY RESOURCES

Language Center Is Open to All

Members of the MIT community are invited to drop by the Language and Learning Resource Center (LLARC) in Rm 20C-130 to use the Center's videotaped language courses, listen to television broadcasts

from around the world, or otherwise enjoy the LLARC's facilities, according to Ruth Trometer, director of the Center.

Completed last spring, the LLARC includes a number of state-

of-the-art technologies to help students of any age learn a new language. For example, the Center features award-winning interactive video-computer programs in French, Spanish, Russian and English as a Second Language. In these programs the user participates with characters on video through a computer, affecting the outcome of the story while developing language skills and gaining cultural experience.

The LLARC also offers videotaped language courses in French and Russian, and many basic language courses on audio cassette.

Students who have taken courses in MIT's Foreign Languages and Literatures section are already familiar with the LLARC's two classrooms equipped with cassette, CD and laser disc players, as well as video and computer monitors. The video facilities include two tri-standard VHS systems capable of playing videotapes from around the world.

Finally, a satellite hook-up accesses television programming from around the globe. In particular, the SCOLA hook-up provides international news programming.

During the semester LLARC is open Monday through Thursday, 8:30am-10:30pm; Fridays from 8:30am-3pm, and Sundays from 1-10:30pm. For more information, call x3-9779.

Sports at MIT

FOOTBALL

MIT football players Jon Duran and Rod Tranum have received pre-season honors from College Football Preview magazine. Duran, a sophomore from Las Vegas, Nevada, is a preseason All-America selection at offensive guard. Tranum was picked as a national scholar-athlete by the publication. A wide receiver from Chatsworth, Ga., who earned first-team Eastern Collegiate Football Conference all-star honors in 1990, Tranum will be entering his junior year.

CREW

Two MIT alums captured medals at the Pan American Games held in Havana, Cuba, earlier this month. Rowers Marvin Guiles and Linda Muri, each of the Class of '86, rowed in two-person boats. Muri won a silver medal in the open women's doubles, while Guiles brought home a bronze for his efforts in the lightweight men's pair. Another alumnus, Jim Pierce '88, was a member of the United States lightweight four without coxswain which finished sixth in the World Championships in Vienna, Austria.

NEW COACH

Cheryl Silva of Wellesley has been named varsity field hockey and women's lacrosse coach at MIT. Ms. Silva has served as assistant coach in both sports at Wellesley College since 1989.

Roger Crosley

Pollution Prevention To Be Workshop Focus

(continued from page 1)

The first three workshops will present the case studies and will be led by company representatives. The fourth workshop will explore how participants can apply similar principles to their own work settings. Descriptions of the workshops follow.

"From Pollution Control to Zero Discharge—Overcoming the Obstacles," on Wednesday, Sept. 4, will focus on The Robbins Company, a small plating firm. In 1988 the company implemented a "closed loop" system that eliminated waste-water discharges, according to the program brochure. Deemed a success, the system has "improved environmental performance, drastically reduced environmental operating costs, avoided major legal problems, and improved sales and corporate image."

"Measuring Toxic Use and Waste

as a Tool in Reducing Pollution," on Wednesday, Sept. 11, will explore how the Polaroid Corporation "tracks nearly every material entering or leaving the company, from chlorinated solvents to office paper." This environmental accounting and reporting system "is the most comprehensive system in use by any major firm."

"Preventing Waste Beyond Company Walls: A Proactive Approach," on Thursday, Sept. 19, will discuss how pollution prevention "requires that companies take responsibility for the entire life cycle of their products and packages, from production to disposal." The workshop will focus on Procter and Gamble's efforts to that end. For example, the company has concentrated its detergents to reduce the amount of packaging and is using recycled plastic in many of its bottles.

Finally, "Preventing Pollution in

Your Work Setting," on Wednesday, Sept. 25, "will pull together themes emerging from the three cases and consider their implications for a broad array of work settings."

All workshops will be held from 4 to 6:30pm in E51-144. Registration is free for members of the MIT community. To receive a registration form or for more information, call Jennifer Nash at x3-0902. Attendance is limited to 50, so interested persons are encouraged to contact Ms. Nash as soon as possible.

The workshop series is sponsored by the EPA through the Hazardous Substances Research Center, a consortium of the New Jersey Institute of Technology, Tufts University and MIT. Dr. Ehrenfeld is coordinator of the MIT branch of the center, the Hazardous Substances Management Program.

Elizabeth A. Thomson

Magnet Lab Funded for 4 More Years

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and Bitter (water-cooled) magnets, would achieve a magnetic field 900,000 times the strength of the Earth's magnetic field. The 45 tesla magnet, now in design, is expected to be 4 meters in height and 3 meters in diameter (roughly 13 feet tall and 10 feet wide). The magnetic field is achieved at the center of the magnet in a cylinder about 1-1/2 inches in diameter, where the scientific experiments take place.

The NSF announcement said: "The 4-year award to MIT will help ensure that scientists who must use powerful magnets for their research will have access to this highly sophisticated

technology." Dr. Mary Good, chairman of the NSB, said the NSB action "will help the US maintain its position in high magnetic field technology."

The NSF announcement also quoted Dr. Jack E. Crow, director of the NHMFL, a joint project of Florida State University, the University of Florida and the Los Alamos National Laboratory in New Mexico. Dr. Crow said "The NHMFL is very excited about collaborating with MIT on this project. These interactions will exemplify the outstanding tradition and research accomplishments that have characterized the Francis Bitter National Magnet Laboratory."



THE ARTS

September at MIT

8/30-9/1 Fri/Sun

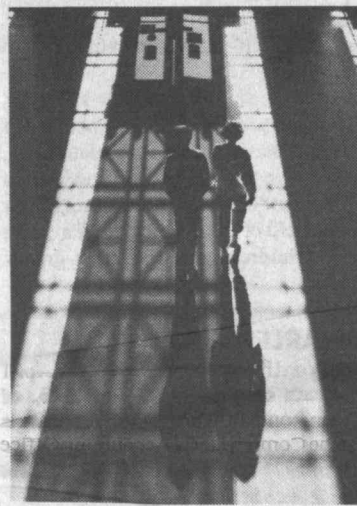
Sweeney Todd

MIT Musical Theater Guild presents the story of "The Demon Barber of Fleet Street," by Stephen Sondheim. 8pm, Kresge Little Theater. \$8; \$7 students/seniors/MIT staff; \$5 MIT/Wellesley students. 253-6294

1 Sun

Photo Exhibit Closes

Last day to see exhibit of prize-winning photographs relating to life at MIT, below. Strobe Alley, Bldg 4, 4th Floor. 253-4444



3-20 Tues/Fri

Live with Art

Annual Student Loan Art Exhibition and Lottery. More than 340 contemporary prints and photographs from MIT's permanent collections, below, all available for one-year loan to MIT students and student groups. Application deadline for lottery selection: 6pm, Sept 19. Weekdays 12-6, Weekends 1-5. 253-4680



5 Thurs

Freshmen Explore Theater Arts

Theater Arts Design and Technical Staff offer a Freshman Exploration of the set and costume shops and storage areas. Opportunities in design, construction, lighting, and stage management discussed. Meet at 10am at E20 (Amherst Street near the corner of Ames St). 253-0862

5-7 Thurs/Sat

Sweeney still Barbering

See 30-1 Fri/Sun above.

6 Fri

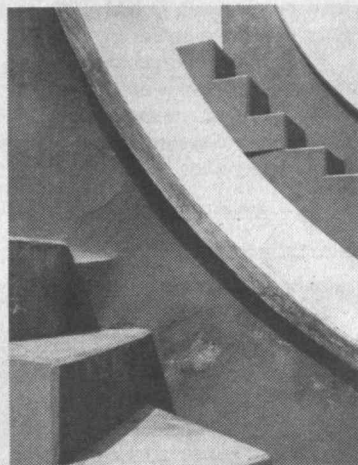
Yeomen Sing-Through

Sing-through of *Yeomen of the Guard*, to be produced by the MIT Gilbert and Sullivan Society this fall. (Auditions next week.) 6-11pm, Kresge Rehearsal Rm A. 253-7744 or 625-0229

8 Sun

Photos from India/Nepal Closes

Made of Light: Photographs from India and Nepal. A visual essay of Jantar Mantar, the Celestial Observatory at New Delhi as well as photographs of the architecture and sculpture at Mamallapuram and the temples and shrines of the Kathmandu Valley, below, by Barry Perlus, Assistant Professor of Art, Cornell University. MIT Museum. See Museum information below.



Jazz Auditions

Concert Jazz Band and Festival Jazz Ensemble Auditions. Be prepared to sightread from standard jazz band book — solos encouraged. 7pm, Kresge Auditorium. 253-2826

9 Mon

Chamber Audition

MIT Chamber Music Society Audition. Prepare brief solo piece. 7pm, Killian Hall (14W-111). 253-2826

10 Tues

Brass Audition

MIT Brass Ensemble Auditions. Student ensemble conducted by trombonist Lawrence Isaacson. 5pm, Killian Hall. 253-2826

Selection of the "Guard"

Gilbert and Sullivan Society auditions for *Yeomen of the Guard*. Bring a prepared song. 6-11pm, Kresge Rehearsal Rm A. 253-7744 or 625-0229.

Symphony First Meeting

MIT Symphony Orchestra, conducted by Prof. David Epstein. Be prepared to read through some symphonic literature and sign-up for audition time. Auditions will consist of a prepared solo work. 7:30pm, Kresge Auditorium. 253-2826

11 Wed

Chamber Try-Outs

MIT Chamber Orchestra auditions. Open to all members of MIT community; preference given to students. Bring solo or partial solo piece. Be prepared to sightread from standard orchestral repertoire. 5-7pm, Student Ctr Rm 491. 942-2484

Theater and Dance Open House

Meet the folks who produce MIT theater and dance events: Dramashop, the Shakespeare Ensemble, Musical Theatre Guild, Tech Random Music Ensemble, The Gilbert and Sullivan Players, and the Dance Workshop. 7:30pm, Kresge Little Theater and Rehearsal Rooms. 253-2877

Concert Band Audition

MIT Concert Band, conducted by John Corley and made up of students and alumni. Auditions primarily for seating within a section. 8pm, Kresge Auditorium. 253-2826

12 Thurs

Museum Watercolor Show Closes

Watercolors by Freddy Homburger. Landscapes, primarily of Mexico and Maine by Freddy Homburger, physician, scientist, diplomat, artist who studied under Raoul Dufy. See Museum information below.

12-14 Thurs/Sat

Sweeney's Last Shave

See 30-1 Fri/Sun above.

13 Fri

More Yeomen Auditions

See 10 Tues above.

15 Sun

Postcards from Ogunquit Closes

Sixty *pochades*, or quick oil sketches, and several larger works by Charles H. Woodbury, the 1886 MIT alumnus and turn-of-the-century American painter, which show different aspects of the artist's talents, below. MIT Museum, additional information, see below.



16 Mon

Chamber Chorus Audition

MIT Chamber Chorus, small all-student group directed by John Oliver. Bring prepared piece; accompanist provided. 6pm, Rm 2-190. 253-2826

Concert Choir Audition

MIT Concert Chorus, a 75 voice all-student chorus directed by John Oliver. Auditions in groups; no solo piece required. 7:30pm, Rm 2-190. 253-2826

16-17 Mon/Tues

Shakespearean Apprentices

Shakespeare Ensemble auditions for apprentice program. 4-6pm, Rm W20-423. Call for appointment, 253-2903

Dramashop Auditions

Fall Major Production of Calderon's *The Mayor of Zalamea*, directed by Michael Ouellette. 7:30-11pm, Kresge Little Theater/Rehearsal Rm A. 253-2877

19 Thurs

Chapel Concert

John Curtis, classical guitar, below. 12noon, MIT Chapel.



Art Lottery Deadline

Last day to sign up for the Annual Student Loan Art Lottery. 6pm, List Visual Arts Center. 253-4680

"Crisis in American Universities"

MIT Writing Program Writers Series lecture by Camille Paglia, below, scholar/critic known for her objections to many of the views of present-day scholarship and teaching. 8pm, Rm 10-250. 253-7894



20 Fri

Musician Behind the Desk Concert

TBA. 12noon, Killian Hall

Buckminster Fuller Show Opens

Buckminster Fuller: Harmonizing Nature, Humanity and Technology. Retrospective on the life and work of the late visionary scientist, philosopher, and Renaissance man includes geometric constructions, models, and drawings of experimental furniture, cars, and inventions, and other photographs and artifacts from Fuller's personal collection. MIT Museum. See information below.

20-22 Fri/Sun

We Have Always Lived in the Castle

Original adaptation of Shirley Jackson's gothic tale of family love. Presented by Kristin Johnson, Jennifer Johnson, and John Peitso, List Visual Arts Center gallery attendants. 8pm, Killian Hall, except 7pm Sun. Free for MIT community, \$10 general, \$6 seniors. 242-3855

21 Sat

Hack Show Closes

Crazy After Calculus: Humor at MIT. Photographs, cartoons, collection of artifacts documenting a rich history of MIT wit and wizardry shown through "hacks" — elaborate practical jokes involving a mastery of humor and/or engineering technique. (Reopens Oct 31 at MIT Museum.) Off Lobby 10. 253-4444

23 Mon

Japanese Film

The Political Game, a story of mass bribery, mud-slinging, corruption, greed, and lies in regional Japanese elections. The first of three "bad guy" films shown by the MIT Japan Program and the Japanese Language Program at MIT. \$3 donation (or \$8/3 films, \$5/2 films). 7:30pm, Rm 10-250. 253-8095

25 Weds

Arts Grants Deadline

First round of applications due for 1991-92 funding of arts activities and projects by the Council for the Arts at MIT. Forms are available at the Office of the Arts, E15-205. 253-4003

26 Thurs

Quartet in Chapel

Mannheim Quartet performs Pleyel, Rossini, and Viotti. 12noon, MIT Chapel

27 Fri

Musician Behind the Desk Concert

TBA. 12noon, Killian Hall.

28 Sat

Duo Piano Recital

Genevieve Chinn and Allen Brings, duo-pianists. Mozart's Sonata in F, K. 497; Kraft's Antiphonies; Brings' Sonata; Stravinsky's *Petrouchka*. 8pm, Killian Hall.

29 Sun

Piano Recital

Arthur Rangell. 3pm, Kresge Auditorium.

30 Mon

Kepes Prize Nominations Due

Deadline for nominations for the 1991 Gyorgy Kepes Fellowship Prize given by the Council for the Arts to a member of the MIT community for excellence in the creative arts: architecture, visual and performing arts, and writing. For information call Mark Palmgren, x3-4003.

MIT Museum

Ongoing Exhibits

Doc Edgerton: Stopping Time

Photographs, instruments, and memorabilia documenting the late Harold Edgerton's invention and use of the strobe light.

Harold Tovish: Tenant, 1964-65

Sculptural installation utilizing stroboscopic light by MIT's Center for Advanced Visual Studies Fellow Harold Tovish.

Holography: Types and Applications

Scientific, medical, technical and artistic imaging drawn from the work of the Spatial Imaging Group at MIT's Media Lab.

Light Sculptures by Bill Parker

Vivid interactive light sculptures, each with its own personality and set of moods.

Math in 3D: Geometric Sculptures by Morton G. Bradley, Jr.

Colorful revolving sculptures based on mathematical formulae.

Mathspace

Hands-on exploration of geometry is the theme of this new room located adjacent to geometric sculptures where visitors can tinker with math playthings.

MIT Museum Hours

Tues-Fri 9-5, Weekends 12-4. Closed holidays. 265 Mass Ave. 253-4444

All events are free unless prices are noted. All concerts: 253-9800 unless otherwise noted. MIT Arts Hotline: 253-ARTS. Month-at-a-Glance is produced by the MIT Office of the Arts (253-4003) and ARTSNET. Celia Metcalf, design.

Hoffman: Unlock Math's Beauty with Calculators

■ By **Kenneth M. Hoffman**
Department of Mathematics

Forget the upcoming presidential election or Madonna's new movie. The next time you want to pick an argument with someone, tell them that schoolchildren should be using pocket calculators more often to learn mathematics.

I've said so to people I've met on airplanes and at parties, and they often look at me like I'm crazy. "If children use calculators in class," they sputter, "how will they learn the multiplication tables?" Or "Students will know how to push the buttons but won't understand the underlying mathematics."

Then they tell me about the time they went to the store when the cash register wasn't working and the teenage cashier didn't know how to make change.

The very idea of using calculators in classrooms hits a vital nerve in many Americans. They view it as

cheating and fear that our already dismal level of performance in mathematics will worsen.

As one who has spent a lifetime teaching mathematics, I disagree profoundly. There is no evidence that the average young cashier today is any worse at arithmetic than teenagers were 50 years ago, although the growth of the service sector does make their inadequacies more obvious. Teenagers of the past depended on a pad and pencil instead of on a cash register. In practical terms, what's the difference?

The real problem with calculators, I think, is that many Americans view math as something painful that youngsters must study because it's good for them. If Mom and Dad spent countless hours doing long division problems then, by God, Jason and Kimberly can too.

Such attitudes explain why our students perform so miserably. They have been led to view math moralistically rather than as a liberating tool for understanding the world. Mathematics is

seen as a test not only of brains but of character, of whether someone has the grit to calculate problems day after day, year after year.

No wonder people hate it.

Calculators can change this equation. Students still must master the basic skills, but now they can escape the drudgery of endless repetition and do new and exciting things. Elementary school students, for instance, can use calculators and other tools to explore subjects now reserved for higher grades, such as geometry.

Suppose youngsters spent as much time learning about volume and area, by pouring liquids from one container to another, as they now devote to long division. They could discover that a cylinder holds enough liquid to fill three cones with the same base and height as the cylinder. They'd find that three spheres hold just enough liquid to fill two cylinders that have the same radius as the spheres and a height equal to the spheres' diameter.

Centuries ago, Archimedes said

these relationships are among the most profound truths of nature. Why shouldn't our students have the chance to discover them as well?

Similarly, children should be using blocks and tiles to learn that doubling the sides of a square results in an area four times as great. For older children using calculators, it then is a short step to learn about fractals, chaos, and other topics that go far beyond the clerk-training curriculum now in place.

Young children can learn about statistics by measuring the heights of their classmates. A teacher then can guide them to consider ways of determining the center. Is it the average of the heights, the height in the middle or the height that occurs most frequently? Calculators make it possible to assess these possibilities quickly, keeping students focused on the big picture.

Contrary to many people's assumptions, mathematics is not an unchanging body of facts and procedures. It is the language of science, and it evolves continually. When chalkboards were

introduced in schools many years ago, some teachers feared that children would lose the ability to write. Modern worries about calculators are likely to prove similarly groundless.

Technology is not a panacea, as many school systems have learned with computer-based learning materials and other reputed innovations. Dedicated teachers and sound pedagogy remain essential. Yet, used appropriately, calculators can make the job easier, and we should not fear them. They give students what their parents lacked: time and freedom to become better problem solvers and to discover the beauty of mathematics.

(Dr. Hoffman is professor of mathematics and associate executive officer for education at the National Research Council. This op-ed piece was prepared for distribution by the National Academy of Science Op-Ed Service and is reprinted here with permission.)

Team Finds New Way To Create Fullerenes

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dent in chemical engineering, performed theoretical calculations to interpret the experimental data from the flames.

Sure enough, the results of these studies "looked very intriguing," Professor Howard said. "There was evidence that C_{60} might be present." But the scientists couldn't isolate the elusive buckyballs, and the results were inconclusive.

Other researchers around the world were also working to find a new way to produce fullerenes. The Rice group had paved the way by identifying buckyballs and suggesting their structure, but their technique produced only very small quantities of the molecules—barely enough for scientists to study.

Then last year, in work that Professor Howard says is equal in importance to the initial discovery of fullerenes, researchers at the University of Arizona and the University of Heidelberg found a way to produce the material in grams. The work also led to a breakthrough for the MIT scientists.

Using separation techniques from the Arizona/Heidelberg work, McKinnon analyzed soot from the laboratory vacuum cleaner. Used to clean the burner he had worked with for about five years, the vacuum held the only substantial sample of possible fullerenes in the lab.

The results were even more encouraging than the probe studies, so Howard and McKinnon did a set of experiments in which the flame conditions were varied over ranges expected to favor fullerenes. Finally, working with Elaine Johnson, now a junior in chemical engineering, and staff chemists Yakov Makarovskiy and Arthur Lafleur, the scientists worked out a way to make buckyballs in a benzene flame.

The MIT procedure has two primary advantages over the Arizona/Heidelberg technique, which produces fullerenes by vaporizing rods of graphite. First, flame synthesis of fullerenes could be scaled up for industry because similar processes are already widely used there. For example carbon black,

which is essentially soot with special properties that give tires strength and resilience, is produced by a flame system.

In contrast, while the Arizona/Heidelberg technique is easy to use in the lab, "it might be very cumbersome to scale up for industry," Professor Howard said. With the MIT technique, he envisions a system that "could operate continuously with simply a gas or liquid fuel being pumped in and soot being collected and processed, in much the same way as carbon black is processed today."

Professor Howard points out, however, that the MIT technique operates at below atmospheric pressure. "That will be an important difference from current flame reactors," he said. "Carbon black furnaces typically run at atmospheric pressure."

The new procedure is also interesting because the scientists have found that they can control the yields of C_{60} and C_{70} by changing the flame conditions. That could lead to "a kind of tailoring" to produce more of one fullerene than another, Professor Howard said.

Since the discovery of fullerenes in flames, the MIT scientists' research efforts have grown. Saibal Mitra, a postdoctoral associate, joined the group this March. Robert Juba, a senior in chemical engineering, and Joshua Fedderly, a sophomore in physics, joined this summer. Christopher Pope is continuing his theoretical work on fullerenes for his PhD thesis, and Tom McKinnon is starting a new fullerenes research project at the Colorado School of Mines where he is now an assistant professor.

One of the major emphases of the work at this point is to understand how fullerenes form. "How do they get started and how do they grow to become these amazing hollow-caged structures?" Professor Howard said.

Further, what are the other fullerenes, besides C_{60} and C_{70} ? According to Professor Howard, there are some smaller and many larger. Fullerenes C_{200} through C_{300} have been found elsewhere. "It's difficult to imagine closed-shell structures that large, but those are the reports," he said.

The scientists would also like to do more work on enhancing the production of one fullerene over another. In addition, they are exploring the production of fullerenes with metal atoms inside or outside the hollow cages. Such materials, of interest for making superconductors and catalysts, may be possible to produce in flame systems, Professor Howard said.



SUMMER PICNIC—Jim Sweeney (left) of purchasing and Jack Silvey, who worked at the Servo Lab, chat over drinks at the annual Quarter Century Club picnic. Evelyn Sweeney and Juny Silvey are at center left and right, respectively.
Photo by Donna Coveney

STUDENTS FROM ABROAD

Open House to Welcome Newcomers

The 20th annual International Open House to welcome newcomers from abroad and their families will be held Wednesday, Sept. 4, 9:30am-5pm in the Bush Room (10-105).

Representatives of campus organizations and helping groups will be there to distribute information about their

programs and activities, including information for wives about English Classes, the Wives Group, Technology Community Women and the MIT Women's League.

Faculty and staff members and students are urged to stop by during the day to greet some 350 newcomers expected

to attend. The Open House is informally organized so that those arriving can chat with others, getting to know something about MIT and the Boston area and resources available.

Also on Wednesday evening, Professor Samuel Jay Keyser, associate provost, will chair a discussion on teaching and learning styles at MIT. Also participating will be Professors Alvin W. Drake (electrical engineering and computer science); Margery Resnick (foreign languages and literatures); Frank Solomon (biology); Lester C. Thurow (dean of the Sloan School of Management), and J. Kim Vandiver (ocean engineering).

The events are sponsored jointly by the Medical Department and the International Students' Office. For further information, call x3-1614.

New Students Arrive on Campus

(continued from page 1)

ference with their faculty advisor will take place at 12:30 on Kresge Oval (Johnson Athletics Center, in case of rain). An Academic Expo to show the new students what the departments are doing will fill the Johnson Center during the afternoon.

The final major event is Book Night on Thursday, Sept. 5, at 4pm in Kresge Auditorium. Earlier this summer all new students received a copy of David Halberstam's *The Next Century* to read in preparation. Dean Lester C. Thurow will discuss the book in a session for everyone to be followed by continued discussions over dinner in the living groups. More faculty members are still welcome to sign up for living-group discussions, and may do so by calling Donna Friedman at x3-9762.

More than 40 upperclass students participated in planning and arranging this year's R/O, working intensively during the summer. They were led by Michael Pieck, a senior in EECS from Plains, Ga., Emily Prenner, a junior in chemistry from Roslyn Estates, N.Y., and Sue Raisty, a

senior in EECS from Stoughton.

The Class of 1995 is expected to number 1,060 with 685 men and 375 women. It includes 174 under-represented minorities, an increase of 30 over last year. The freshmen represent 47 states and the District of Columbia and 39 other countries. Not included in the count are 65 students coming to MIT from other universities.

Nominations Wanted

The Medical Consumers' Advisory Council seeks nominations for two positions on the council: one from among support staff members and the other from the Draper Laboratory. Both must be members of the MIT Health Plan.

The Medical Consumers' Advisory Council, a presidentially appointed committee, serves as a communications link between the Medical Department and its users. Its objectives are to keep the MIT com-

munity informed of the services available through the Medical Department and to discuss criticisms and needs of the community.

Any support staff or Draper Laboratory staff member interested in being considered, or anyone who can suggest the name of a good candidate, is invited to submit name, room number and extension to Constantine B. Simonides, vice president in the Office of the President, Rm 3-209.

Lincoln Lab

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tion of advanced radar technology. Its work has also led to a number of important applications in air traffic control as well as to the establishment of several dozen spin-off companies, including Digital Equipment Corp., Computer Corporation of America and Electronic Space Structures, Inc.