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MIT Faculty Newsletter

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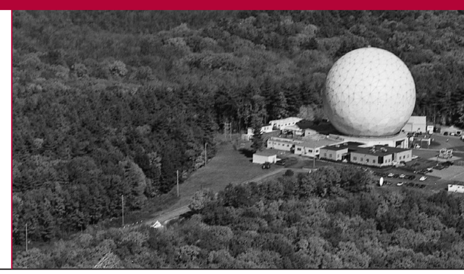
this issue features the Faculty Policy Committee "Statement on Representation of Minorities on the Faculty and in the Graduate Student Body" (page 3), updates on the status of women faculty in the Sloan School and the School of Architecture and Planning (page 7), three articles in our continuing Research at MIT feature (beginning page 8), MIT Poetry (page 13), a report on the changing environment of scholarly journals (page 19), "Security on the MIT Campus" (page 21), an OpenCourseWare Update (page 22) and our M.I.T. Numbers feature offering initial results from the Faculty Survey (back page).



Leadership, Management, and Education at MIT

Thomas W. Eagar

THE WORLD LOOKS TO MIT for leadership. And this leadership is not limited to science and technology, as was demonstrated forcefully several years ago when Scott Krueger overdosed on alcohol. Scott's death became front page news, not only in Boston but across the country and around the world. How could such a "gifted" person do such a thing asked one article; even though dozens of college students at other universities do the same thing every year? An MIT student doing such a thing is national news; the world holds MIT to a higher standard.

These expectations are not new. In a newspaper interview on December 17, 1911, Thomas Alva Edison was quoted, "There is no question but that the Massachusetts Institute of Technology is the best technical school in the country . . . . I have found the graduates of Tech to have a better, more practical, more usable knowledge, as a class, than the graduates of any other school in the country . . . . The salvation of America lies in the Massachusetts Institute of Technology." For a number of years, I have reflected on how such grand expectations have developed, and what makes MIT unique.

Clearly, one answer is that the faculty and students who have preceded us have accomplished much; but the same can be said for other notable universities. Our students have very high qualifications, but other schools' students have equal or even higher

continued on page 16

From The Faculty Chair

FPC Statement on Representation of Minorities

Rafael L. Bras

IN THE LAST FACULTY NEWSLETTER I discussed issues related to faculty governance. In that article I wrote: "The Faculty Policy Committee, the over-arching committee in the existing (faculty governance) structure, has the charge to 'maintain a broad overview of the Institute's academic programs, deal with a wide range of policy issues of concern to the faculty, and coordinate the work of the faculty committees.' Very quickly FPC finds itself playing the role of the gatekeeper to the faculty meetings, giving final approval to recommendations by other committees, or serving as a sounding board of ideas arising largely from the administration. Indeed, that is a necessary function – but what is lacking is the strategizing role, the faculty body who can think of issues and define positions to be taken by the faculty which in turn can help and guide the administration."

The existing Faculty Policy Committee decided to spend a fair amount of its time being pro-active in the formulation of policy, developing positions that would hopefully influence Institute policy. Following is a white paper, a set of recommendations, resulting from addressing the faculty diversity issue. We hope that all faculty read this carefully. Changes in the composition of the faculty will only occur when we modify our attitudes and bring the issue to the forefront of our hiring practices.

continued on page 3

contents

Vol. XVI No. 5 April/May 2004

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Faculty Policy Committee

Statement on Representation of Minorities on the Faculty and in the Graduate Student Body

Members of the Faculty Policy Committee who contributed to this piece are: Rafael L. Bras, Paola Rizzoli, Ken Manning, Kirk Kolenbrander, Lorna Gibson, Vijay Kumar, Anne McCants, Ernst Berndt, Mary Fuller, Ahmed Ghoniem, Leslie Norford, Yun-Ling Wong ('04), and Krishnam Sriram (G).

Introduction

THE FACULTY POLICY COMMITTEE considers diversity in the professoriate, the student body, and the staff an issue of strategic importance to MIT. FPC takes for granted the arguments of equal opportunity, justice, and the socio-cultural value of a learning environment representative of the larger community. FPC is also convinced that our commitment to excellence and our proud adherence to the recognition and promotion of merit require that we reach out to a more diverse community.

The percentage of underrepresented minorities (African Americans, Hispanic Americans, and Native Americans) and women in the science and engineering workforce is less than half of what it should be relative to the overall population (The Talent Imperative: Diversifying America's Science and Engineering Workforce, Building Engineering and Science Talent (BEST), 401 B St., Suite 2200, San Diego, CA, April 2004). Demographics would seem to indicate that this situation would probably grow worse in the foreseeable future. If MIT fails to get the best of this "missing population," then we will be also missing the fastest growing pool of talent in the nation and ultimately will be unrepresentative of the groups that will become the economic engine of the United States. Already over 35% of the professoriate in engineering, 25% in mathematics and computer sciences, and 20% in the physical sciences are foreign-born (National Science Board, Science and Engineering Indicators 2000, report NSB-00-01, National Science Foundation). Without this reliance on the best and the brightest from other parts of the world, the nation will have difficulty staffing higher education and research in science and engineering. But as opportunities develop in this increasingly integrated world, this source of foreign-born brainpower can be expected to diminish. Our hope (and obligation) is to educate and hire from the largest group, and the largest untapped source of talent, in our own population: women and underrepresented minorities.

This document is written with the explicit understanding that when the term "minority candidate" is used, the authors assume that such a person is qualified by criteria MIT applies in its selection for all candidates for a given position. Only qualified individuals hold positions at MIT, whatever the race. While our focus is on underrepresented faculty as defined by the Institute in its policies, we note that in some areas and schools Asians are not adequately represented on the faculty in particular areas, especially in the School of Humanities and Social Sciences, given the composition of Asian students in the undergraduate population.

An Assessment of the Present

The following three figures (next page) summarize the representation of women and underrepresented minorities on the MIT faculty and in the student body. The first figure shows the time history of the number of women in the faculty with the number of underrepresented minorities in the faculty. The number of women faculty shows a steady growth, particularly since 1998-99, although examination of this figure and the next also reveals that it will be many decades before the percentage of women faculty equals the percentage of women in the pipeline (defined as women receiving PhDs.) The graph showing the number of minority faculty is more discouraging. This number remains stagnant, and is not even at its all-time high at present. The stagnation reflects limited hiring and limited success in the promotion of underrepresented minorities.

The second figure shows that the undergraduate population exhibits a significant growth in the number of women. The graduate population also has grown, initially not as quickly, but at a healthy pace that parallels growth in the women faculty ranks.

The third figure tells a different story. The percentage of underrepresented minorities has grown (there is a hint of stagnation lately) in the undergraduate population, but there is no percentage growth in the graduate population, which is as flat as the minority faculty time history. It should be noted that the absolute number of underrepresented minorities in the graduate student body has increased (from about 200 in 1994 to about 280 now), but that it has not kept pace with the increase in the graduate student body during the same period.

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Statement on Representation of Minorities
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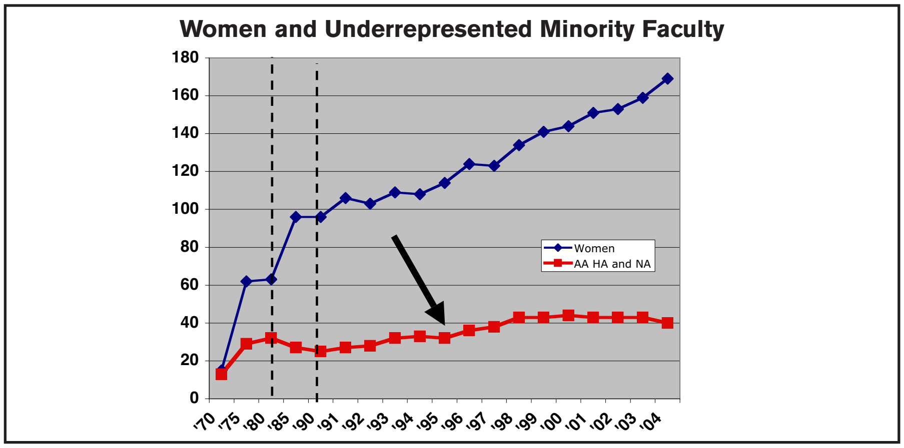

Figure 1. History of number of women and underrepresented minorities in the MIT faculty. Note that the scale changes after 1990 when the data is shown yearly.

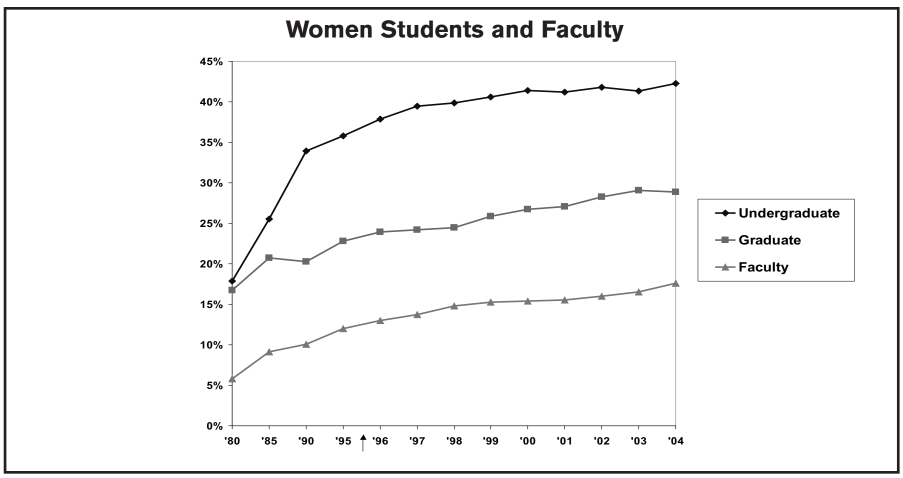

Figure 2. History of women in the faculty and student body. Note change of scale after 1995.

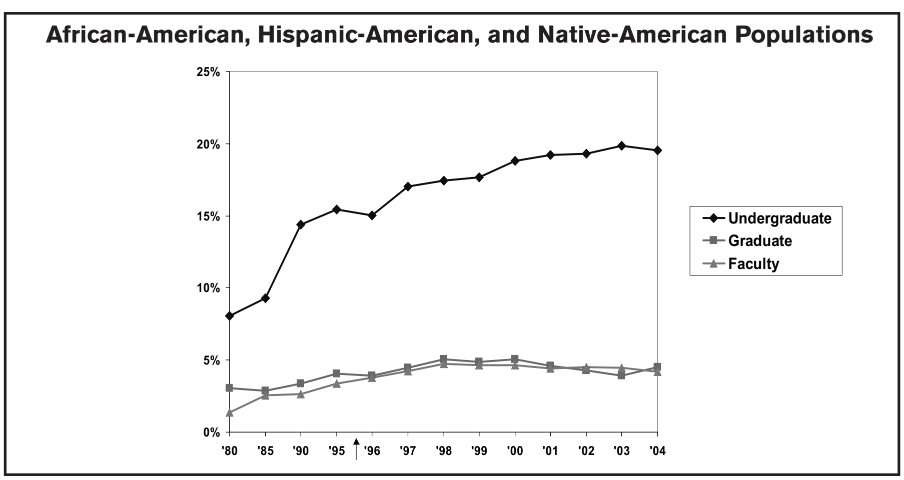

Figure 3. History of underrepresented minority faculty and students, as a percent of the total populations, from 1980 to the present. Note change in scale after 1995.

Source for all charts: Office of the Provost.

There is an undeniable correlation between the momentum of recruitment and hiring of women to the faculty and the graduate student body and the emergence of uncompromising leadership among the women faculty, as represented by the Women in Science report of 1999 and reports from each of the five schools that led to the establishment of the five Gender Equity Committees. This movement accomplished the documentation of problems, the rallying of the women faculty behind a cause, and the admission by the MIT administration that a problem existed and needed to be addressed. Since then, gender has been a more visible issue in many decisions within the Institute. We now need to stimulate the same kind of momentum on the minority faculty issue – namely, collect data and interview both minority students and faculty to identify key issues that may help to explain our failure to make progress. Then, through collaboration with faculty colleagues in the various departments and members of the administration, we must take steps to address the issues identified.

Strategies for Change

It is too easy to attribute the small number of minorities in the faculty solely to a pipeline issue. The argument is that there are not enough qualified candidates to fill the available positions, and that there is therefore a dearth of minority applicants for open positions. But although the pipeline is leaky between undergraduate and graduate education, in terms of underrepresented minorities nationwide, it is not empty. FPC believes that there are qualified candidates available. Being very generous in the counting, there are now some 40 underrepresented minorities on the MIT faculty. Hiring even 3-4 individuals a year (less than 10 percent of our annual hiring) would make a significant difference. MIT alone has 280 underrepresented minority graduate students, and other academic institutions around the country have similar numbers. Few would dispute the fact that some fields are reasonably well-populated by minorities nationwide. Even accounting for the poor historic performance of academic institutions in educating minorities, there is enough of a pool nationwide to break the inertia in minority hiring at MIT. But to find the top candidates that we want, we must begin by making ourselves attractive and welcoming to minorities. So far, we have not done so. Recruiting the best minds is never a "business as usual" exercise. Recruiting the best minority faculty candidates, however, requires even harder work and increased willingness to compete.

A strategy to change the composition of the faculty and the graduate student body must be multi-dimensional and strongly supported throughout the Institute, at both the grass-roots efforts of the faculty and the upper levels of the administration. Following are a few propositions and action items in several important dimensions.

Commitment from Below

Faculty in the departments and academic units are the first and foremost effective agents for recruiting, hiring, and retaining minority faculty.

– Each faculty member must accept responsibility to bring minority candidates within his or her profession, or through other appropriate networks, to the attention of his or her MIT colleagues, department head, and dean in routine searches, as well as for appointments as targets of opportunity.

– Each faculty member should strive to insure that all searches within his or her department give due attention to equal opportunity for minority candidates.

– Colleagues in every academic unit should strive to insure the success of minority faculty through appropriate mentoring and guidance throughout the faculty member's career, especially in the early stages.

– Faculty members should be recognized and rewarded on an individual basis by the department head, dean, and upper-level administration for outstanding efforts to attract, recruit, and retain minority faculty.

Commitment at the Top

The evidence indicates that one of the most effective ways to overcome the inertia of recruitment, hiring, and retention of minorities is for the leadership to signal unequivocally their commitment to the solution of the problem, with attendant consequences and rewards.

– The upper-level administration must repeatedly convey the message, in word and deed, that minority recruitment is a very important issue. This involves open debate and discussion in every possible forum.

– Deans must be unwavering and uncompromising with departments and their leaders about the seriousness of the need to hire minorities. This worked well in the case of women hires, finally convincing some units that excellence was staring them in the eye from among the female ranks.

– The appointment and evaluation of department heads should explicitly consider performance in minority recruitment and retention.

– Minority recruits should have advocates at the highest level of MIT's decision-making and policy-setting bodies; such advocates should be tasked with "problem solving," for example, when issues arise with a potential hire.

Information

We must collect and make available better information both to understand the current situation and to identify where improvements are possible.

– Coordinate efforts on behalf of minority recruitment and retention more effectively.

– Maintain and provide access to accurate data on minority applicants to graduate school, admission rate, and yield.

– Develop a wide array of information on recruitment, including a clearinghouse of information on resources available at MIT and elsewhere.

– Maintain and provide access to centralized information on minority faculty applicants, interviews, outcomes, and promotion histories.

– Gather information on failures to attract students and faculty, including feedback from candidates on their reasons for declining offers.

– Develop and make available a manual of "best practices" for recruitment of minorities at all levels.

Recruitment and Retention of Faculty

As already stated, minority faculty recruitment and retention require an unequivocal message from the top: we want minority hires, men and women. This process can begin by collecting and publishing data relative to minorities at MIT, including issues of retention and promotion, salary, space, leadership roles, etc. Some other general recommendations have been given already.

Action items

– Implement the Council for Faculty Diversity "pipeline proposal," available from the Council.

– Track the progress of all minorities in science and technology, and in the humanities and social sciences.

– Consider making an initial aggressive move to hire in areas identified as not having a pipeline problem (the Council on Faculty Diversity should identify these areas).

– Consider establishing a program to provide postdoctoral experience funds, not at MIT, for individuals whom we are willing to hire once they acquire additional experience.

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Statement on Representation of Minorities
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– Revisit the use of the MLK program as a recruitment tool.

– Require a-priori justification of search committee for not interviewing minority faculty candidates.

– Be willing to hire our own minority graduates.

– Insure that all serious minority candidates meet with members of the senior administration, to make it clear that MIT wants them.

– Provide generous start-up funds.

– Publish best practices and celebrate successes.

– Develop an effective mentoring system, realizing that there are not enough senior minority faculty to mentor new minority hires.

– Create a more transparent promotion process and a way to audit the process through appropriate checks and balances.

– Seek out minority faculty for influential positions within departments and the central administration (department heads, members and chairs of key committees).

– Involve tenured minorities in the selection of administrators.

– Watch for and intervene to prevent the isolation and marginalization of minorities that frequently occur, particularly after tenure.

Recruitment and Retention of Graduate Students

Our success in recruiting undergraduates is largely due to the fact that undergraduate admissions are controlled and governed by the Institute's central policies. The decentralized nature of graduate admissions, however, makes it difficult to apply central policies in a uniform way. This is exacerbated by the inability of the Office of Graduate Education to acquire all the information it needs about admission decisions from the responsible academic departments. A strategy for improving graduate student recruitment would include the following elements:

– Move the system closer to some centralized responsibility with respect to data collection, outreach, improvement of yield, targeted resource allocation, and retention efforts.

– Develop a feeder system of mutually trusted institutions.

– Collaborate with institutions that often hire our students and from which we hire.

– Make our environment friendlier to minorities, including provision of services now available primarily to undergraduates.

– Improve yields of admitted students.

Action items

– Reformulate the standing committees helping to formulate policy on graduate education. The Office of Graduate Education must have increased clout and resources.

– Require that information on admissions decisions, particularly relative to minority candidates, be shared with the Office of Graduate Education.

– Require explanations for each minority-candidate decision, and supply courtesy explanations to supporters of candidates from institutions we wish to cultivate.

– Invite all accepted minorities to visit the campus.

– Identify a few feeder undergraduate institutions and develop a trustworthy collaboration with them.

– Be more aggressive in exerting a presence at venues frequented by undergraduate minority students (GEM, HENAAC, etc.) in order to dispel the perception that we are unfriendly, inaccessible, arrogant, and do not want them.

– Provide centralized support for minority graduate students (OME is largely undergraduate-focused).

– Compile and disseminate best practices of recruitment, admission, yield management and retention.

– Institutionalize and expand the summer research program.

– Change departmental policies that place our own minority undergraduate students at a disadvantage in competing for slots in MIT's graduate programs.

– Implement the Council for Faculty Diversity "pipeline proposal."

Summary

The FPC considers the recruitment of underrepresented minorities to the graduate student body and the faculty an issue of major importance for MIT. There is a lot to be learned from the experience of women at MIT. This white paper outlines some ideas that should be improved on, followed, or implemented. The one clear message, though, is that change requires unequivocal support and strong leadership from the upper levels of the administration. Members of the minority community must also play a leadership role, as their experience and advice are critical to understanding the issues. Progress towards a greater level of diversity will require the effort of all faculty, minority and nonminority alike.

Update on Women Faculty in the Sloan School of Management

Lotte Bailyn

SINCE THE LAST REPORT from the Schools in 2001, there has been a small change in the number of women at Sloan. One woman associate professor with tenure has been promoted to full professor; two women assistant professors have been promoted to associate professor without tenure; two new assistant professors have been added. During the same period we have lost four tenured male full professors; added two male associate professors with tenure; added two associate professors without tenure; and lost two assistant professors. Overall, the faculty has stayed at 97 with two fewer men, and two more women, thus increasing the percentage of women from 15% to 18%.

The Sloan Gender Equity Committee has also finished its report on the junior faculty. They interviewed nine women junior faculty and a matched group of nine men. Overall, there was less difference in the experience of men and women at the junior level than had been found with the senior faculty. There were some issues that affected all junior faculty, particularly around mentoring, and around advice and feedback on the promotion and tenure process. But there also were some gender differences. Junior women faculty have a harder time than their male colleagues establishing their legitimacy with students. They also, like the senior women, express less of a sense of belonging, both on arrival and currently. But the biggest difference was the coded level of stress. Each interview was independently coded by a man and a woman on the level of stress it seemed to represent using a scale from 1 to 5 (=high stress). The men had a mean of 2.7 compared to a mean of 4.2 for the women; the mode for the men was 2, for the women it was 5. And, like the senior women, fewer of the junior women faculty were married or had children.

The report was presented to and discussed at the Sloan Personnel Committee and with the junior faculty. A number of recommendations were made and the deans are working on them. In particular, a more rigorous mentoring system has been put into place. ■

Lotte Bailyn is a Professor of Management *(lbailyn@mit.edu).*

Update on Women Faculty in the School of Architecture and Planning

Terry Knight

IN 2001, THE COMMITTEE on Women Faculty in the School of Architecture and Planning completed its report on the status of women faculty. That same year, the provost issued new, rigorous standards for faculty searches. Since that time, the numbers and proportions of women faculty in the School have increased significantly. In 2001, there were 14 tenure-track/tenured women comprising 19% of the total faculty. Now, in 2004, there are 24 tenure-track/tenured women comprising 30% of the total faculty. In one department – the Department of Urban Studies and Planning – the percentage of women faculty has almost doubled from 20% to close to 40%.

This upswing is due in large part to the commitment and intensive efforts of department/program heads and faculty to find and recruit outstanding women applicants in faculty searches. Additionally, a school-wide Diversity Committee was established in 2002 to oversee faculty searches and to help with women and minority recruitment. The committee interacts with every faculty search committee throughout the search process. It meets with each search committee at the beginning of a search to review affirmative action policies and to help develop a search plan. It reviews the short-list of candidates and outreach efforts before candidates are invited for interviews. It reviews and approves the final search report. The committee keeps a database of advertising venues that target women and minorities, and it evaluates and updates this list when searches are concluded. However, it appears that the most effective recruitment tool is word-of-mouth and personal contacts.

Some next steps: Mentoring and guiding our new junior hires through the promotion process. Continuing attention to minority faculty and student recruitment. ■

Terry Knight is Associate Dean, School of Architecture and Planning *(tknight@mit.edu).*

Research at MIT

The MIT/WHOI Joint Program in Oceanography and Applied Ocean Science and Engineering

Paola Rizzoli

HOW MANY PEOPLE AT the Institute know that MIT, together with the Woods Hole Oceanographic Institution, has what has been defined as "the top graduate program – or arguably one of the two top programs – in marine science in the world"? [MIT/WHOI External Review Committee, 1998.]

The program was created in May 1968 with a Memorandum of Agreement (MOA) between the MIT Corporation and the WHOI Board of Trustees, signed by MIT President Howard J. Johnson and WHOI President Paul M. Fye, thereby establishing that the appropriate graduate degrees in oceanography would be conferred jointly by the two Institutions.

The original motivations for the creation of the program, outlined in the MOA, still stand on strong ground and can be projected into the future even more strongly. The recognition made 36 years ago that "Oceanography is becoming an increasingly important component of the earth sciences" could be rephrased today by emphasizing the crucial role that the oceans play in the science of climate and global change, and the fact that, in spite of the enormous progress achieved in the last 25 years, the world ocean is still the least known and least explored component of the entire Earth's system.

Furthermore, because of the new compelling urgency for understanding and predicting climate change, oceanographic sciences are presently in a "renaissance" period, in which both observational and theoretical components are progressing at a rapid pace in all the sub-disciplines.

And now to the contents of our science: What is Oceanography?

The name is a large "umbrella" for the ensemble of basic sciences and engineering investigated in the context of the oceanic environment. Thus "Physical Oceanography" is "Physics of the Ocean" as well as "Fluid Mechanics" (when the fluid is sea water). [I am a Physical Oceanographer.] Analogous definitions could be given for the other sub-disciplines even though, with the ever increasing importance of interdisciplinary research, the boundaries among the sub-disciplines are becoming more and more blurred. Perhaps the most important example of which is the effort to understand climate and its variability requires not only a close interaction among chemical, physical, and biological oceanographers, but also a close interaction with the atmospheric community.

I will try to illustrate briefly the major scientific issues at the core of each sub-discipline.

Chemical Oceanography is the study of the pathways that chemical species follow on their transit through the oceans. Chemical oceanographers examine vast ranges of time and space scales, from the molecular level to the global in space, from fractions of a second to billions of years in time. Among the focal research areas is the development of new chemical sensors and new technologies to measure the composition of sea water throughout the ocean depth and in marine sediments, as well as to understand the controls on photosynthetic activity of organisms living in the surface ocean.

In an effort to understand past, abrupt climate changes, organic geochemists exploit knowledge of specific biochemical pathways to develop chemical and isotopic tracers of biogeochemical processes and sea water characteristics that have changed over time. Such measurements are carried out from oceanographic

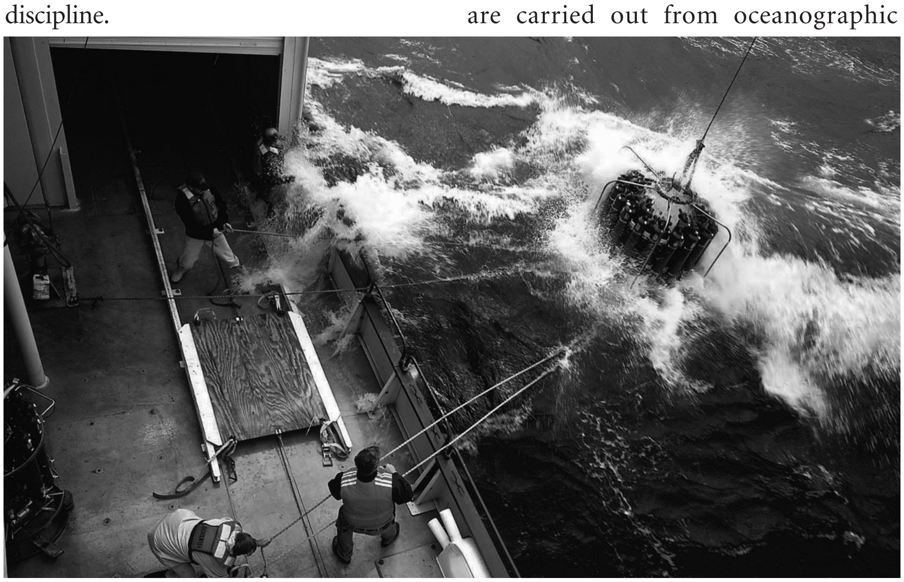

Figure 1. The launching of a "rosette" from the oceanographic vessel *Oceanus*.

research vessels, and Figure 1 shows the launching of a "rosette" from the oceanographic vessel Oceanus. The rosette is an ensemble of containers which are filled by sea water at different depths to measure its chemical and physical composition over large and different regions of the world ocean.

Physical Oceanography is the exploration and study of the physics and dynamics of ocean currents and water properties. Complex oceanic motions occur over a wide variety of space and time scales, from the boundary layer at the air-sea interface, to the grand persistent currents, like the Gulf Stream, and the wind-driven ocean gyres. These large-scale circulation systems transport a substantial fraction of heat from the equatorial zone to the poles, sequester carbon, transport freshwater as part of the global hydrological cycle, and may also precipitate rapid changes in climate. Crucially important in climate research is the study of the complex ocean-atmosphere land-ice interactions, including the reconstruction of the ocean paleoclimate as a key to understanding future abrupt climatic changes. These studies are carried out not only through the collection and analysis of observational data sets but, very importantly, using numerical models of the ocean general circulation (OGCMs). These provide a realistic description of the three-dimensional velocity field, of the temperature and salinity distributions in the world ocean and of their evolution in time.

Figure 2 shows an example of an OGCM simulation of the water temperature at the sea surface at a specific day (a "snapshot"). The system of global currents is reflected in the pattern of the surface temperature.

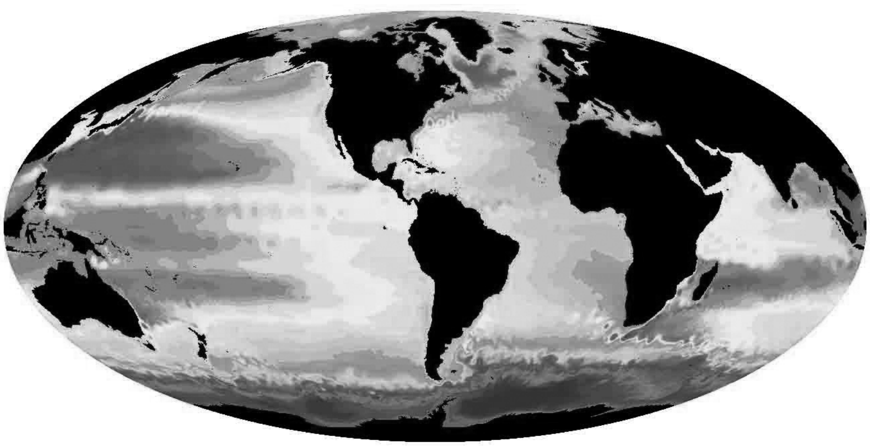

Figure 2. OGCM Simulation of the water temperature at the sea surface.

Biological Oceanography is the study of life in the oceans – the distribution, abundance, and production of marine species along with the processes that govern these features. Biological oceanography is also a study of extremes: in size, from the tiny microbes in the water column to the 30-meter blue whale; in depth, from blooms of cyanobacteria covering thousands of square kilometers of the ocean's surface, to hydrothermal vent colonies emerging eerily from the dark, mile-deep ocean; in locale, from the lab next door to the deck of an oceanographic vessel bucking ice flows in the Arctic.

Among the focal areas of research are the study of the populations of organisms living on the ocean floor (benthic populations); of the distribution and physiological properties of some of the smallest organisms living in the ocean, such as microorganisms, phytoplankton, zooplankton; and the study of large marine mammals, of their auditory systems, social behavior, ways of communication and, in general, of their population dynamics. Figure 3 shows a group of dolphins spotted by WHOI scientists during an oceanographic expedition aimed at investigating the physiology and social patterns of these graceful, highly intelligent animals.

Figure 3. A group of dolphins.

Marine Geology and Geophysics focuses on understanding how our planet works by investigating: the structure of the earth beneath the oceans; the processes that shape the sea floor; the history of ocean circulation patterns and climate change preserved in sea floor sediments; and the interactions between geological and biological systems. Marine geologists approach these problems through studies of oceanic rocks and sediments. Marine geophysicists are primarily concerned with the application of gravity, magnetics, heat flow, and seismic methods to study the structure of the earth beneath the oceans. Focal research areas include understanding how coastal sedimentary systems function for the effective management of costal resources; sediment biogeochemistry, submarine hydrothermal systems and the origin of

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The MIT/WHOI Joint Program
Rizzoli, from preceding page

mineral deposits on the sea floor; melt generation and flow in the earth's mantle; and tectonics, including sea floor volcanic processes, ocean crustal structure, upper mantle dynamics, and ocean-continent interactions.

Fig. 4 shows a flow of lava from the land into the sea: geophysicists study volcanic eruptions on land to better understand those beneath the ocean.

Applied Ocean Science & Engineering is a discipline that combines basic research on a wide range of oceanic processes with applied research and engineering design of systems for the exploration, measurement, mapping, prediction, and beneficial use of the oceans.

Figure 4. A flow of lava into the sea.

Focal areas in the Joint Program include: Observing systems and sensors, which include the development of sea floor observatories, of moored observation systems, sensors and instruments, of optical and acoustical imaging systems; Vehicles and submarines, which includes underwater autonomous and remotely operated vehicles, towed vehicles, navigation and control; Ocean acoustics, that addresses the propagation of underwater sound, both as a scientific problem and as a tool for observing and operating in the ocean, including navigation, sea floor mapping, inference of the physical properties of the water column, underwater communication and signal processing; Environmental fluid mechanics, including surf-zone dynamics, dynamics of estuaries and embayments, turbulence, surface-wave dynamics, sediment transport.

Fig. 5 shows the lowering from an oceanographic vessel of an Autonomous Benthic Explorer (ABE) for the study of benthic populations.

Figure 5. Lowering of an Autonomous Benthic Explorer.

And now a short description of the Joint Program structure. It comprises four departments at MIT: Earth, Atmospheric and Planetary Sciences (EAPS) and Biology in the School of Science; and Civil and Environmental Engineering and Ocean Engineering in the School of Engineering, with occasional participation of Electrical Engineering and Computer Sciences and Mechanical Engineering. The Program has an MIT director who reports to the chancellor, the associate provost, and the provost. In correspondence, WHOI has five departments, one for each of the above sub-disciplines. The Program is directed by the WHOI Vice-President for Academic Programs and Dean, Dr. John Farrington, who reports to the WHOI Director and President, Dr. Robert Gagosian. As of the February 2004 degree list, 480 Doctoral degrees, 56 Masters of Engineering degrees, and 139 Masters of Science degrees have been awarded by the Program. The alumni/ae are among the leaders in ocean sciences and engineering worldwide in academic, industry, nonprofit, and government research and education centers.

The above summaries of research activities in each oceanographic discipline are necessarily synthetic. I hope, nonetheless, to have conveyed the depth and breadth of marine science and the intellectual excitement of being an "oceanographer" today: sophisticated instrumentation mounted on satellites is providing unprecedented data sets of the ocean sea surface properties with synoptic and global coverage; the complexity of ocean interactions, and interactions with the atmosphere, land, and ice, are investigated by extremely sophisticated numerical models of all the components of the Earth's system, often in coupled mode; and at the same time conceptual models are developed to elucidate the basic physical and biogeochemical ocean processes.

If any MIT member wishes to be exposed to this excitement, come see me in the summer at Woods Hole. The Joint Program offers to the MIT faculty involved in it (as well as to students and postdocs) the possibility of spending the summer, or part of it, at WHOI, where we strengthen our interactions with our WHOI colleagues, both in research and education, and work closely with our students in the wonderful setting of Cape Cod: I can assure you that it is a great experience!

For a more detailed description of the research activities in the Joint Program see ***http://web.mit.edu/mit-whoi/www***.

Paola Rizzoli is a Professor (EAPS) and Director of the MIT/WHOI Joint Program in Oceanography and Applied Ocean Science and Engineering *(rizzoli@ocean.mit.edu).*

Research at MIT

The Picower Center for Learning and Memory

Susumu Tonegawa

NEUROSCIENCE TODAY IS ON the cusp of a great adventure. The tools of the field have advanced rapidly in the past few years, and the big research questions have been honed to a point where we are ready to take full advantage of the state of the art. The Picower Center for Learning and Memory is seizing the promise of this moment by focusing a wide range of scientific talents on a single goal: unraveling the mechanisms that drive the quintessentially human capacity to remember and learn.

Only recently have the techniques and technologies of brain research reached a point where it is possible to explore the brain at every level of its complexity – from its molecules to the cognitive system as a whole. Picower Center researchers run the gamut from molecular biology to genetics to physiology to systems biology behavioral studies, and thus are uniquely equipped to build the integrative knowledge needed to build a coherent understanding of the human mind.

The mission of the Picower Center is to understand the mechanisms that allow the brain to learn, remember and think. Established in 1994, the center explores learning, memory, and cognition, as well as development in the growing brain, by using a multidisciplinary approach that addresses every level of brain function from molecules to synapses, neural circuits and behavior.

The Center now includes 13 faculty members and research groups, comprising a total staff of 200. Just a few examples of the latest discoveries from Picower Center labs include the following:

- Focusing on the prefrontal cortex, Earl Miller's laboratory has made several breakthroughs in understanding how we are able to categorize everything we encounter in daily life – how our brains effortlessly assign new things to existing categories almost every minute of every day. The Miller lab showed for the first time how learned concepts such as "cat" and "dog" are stored in individual neurons.

- Building on his early training as an electrical engineer, Matt Wilson developed a new technique that allows researchers for the first time to measure the responses and interactions of large groups of individual neurons. Focusing on specific cells in the hippocampus, Wilson's lab used this technique to analyze the dreams of rats. They found that as an animal learns a route in a maze, for instance, a set of cells in the hippocampus are activated in a certain order, and when the animal is asleep, the cells fire in exactly the same order. In addition to showing that animals dream about their waking experiences, as we do, this work supports the idea that dreams help solidify memories by processing them for long-term storage.

- Elly Nedivi uses molecular biology techniques to unravel which of the brain's genes are involved in making memories. From the full roster of genes expressed in the brain, Nedivi's lab has isolated 315 that probably play a role in memory. Nedivi is convinced that memory-making must take advantage of a complex genetic ensemble. Her lab has already isolated a gene that codes for a protein with two distinct functions: promoting neuronal growth and helping the cell survive. This gene may play a role in early development as well as forming memories in later life. Establishing this fundamental understanding may help design highly targeted drugs of the future for treating disorders such as Alzheimer's, in which aggregations of abnormal proteins kill off healthy brain cells.

- My own work has revealed that the loss of a single type of protein in a tiny subsection of the hippocampus deals a disastrous blow to the ability to learn and remember. Using a technique developed by my lab, we created mouse strains in which a specific gene is knocked out in a particular type of neuron in one part of the brain. Previous technologies only allowed genes to be knocked out throughout the entire organism, allowing much less precise investigation. By observing the physiological and behavioral deficits of these mice, the lab is learning a great deal about the fundamental mechanisms that allow the brain to store and retrieve memories. We discovered, among other things, that a single gene in the hippocampus is critical to both storing and retrieving memories.

All these studies and more by Picower's talented faculty and staff are leading to a comprehensive understanding of fundamental questions about the mechanisms of memory and the basis for learning. Not only will they create new knowledge of

continued on next page

Picower Center for Learning and Memory
Tonegawa from preceding page

how the brain does its amazing job, they also will lead to information that will help cure a range of crippling brain diseases from Alzheimer's to schizophrenia.

The work of the Picower Center will get a further boost in 2005, when it will gain a highly functional and attractive new building of its own. The facility, located on Vassar Street and Main Street on the northeast corner of the MIT campus, will be the Picower Center's first permanent home. It will include 125,000 square feet of laboratories, teaching facilities, a conference center, research and administrative offices, clinical space, and student lounges. Better and larger communal facilities such as those for microscopy and magnetic resonance imaging will permit scientists to pursue new types of projects. Gathering spaces will allow people and ideas to intersect in new ways, fostering cross-disciplinary collaborations inside and outside the Institute.

Supplementing long-term support from the RIKEN Brain Science Institute, a visionary gift in 2002 from Jeffry and Barbara Picower of the Picower Foundation renamed the center, expanded its research base, and contributed to the new building. We at MIT – as well as the world at large – are the beneficiaries of the Picowers' view of the future in which neuroscience helps alleviate crippling diseases and enhances strategies for education. The Picower Center has already made significant contributions along these fronts, and we are poised to achieve much more.

For more information on the Picower Center, please visit our Web site: ***http://web.mit.edu/picower***.

Susumu Tonegawa is a Professor of Biology; Director of the Picower Center for Learning and Memory *(tonegawa@mit.edu).*

MIT's Not-So-Green New Buildings

Leon Glicksman
Les Norford

THERE HAVE BEEN RECENT articles about the Stata building in *The New York Times* and *Technology Review*, describing it as one of the new green buildings in Cambridge. Not withstanding the positive attributes of Stata and Simmons, these are not good examples of green buildings. Stata may receive a LEED silver award; LEED is the Leadership in Energy and Environmental Design Green Building Rating System. Silver is the lowest of the possible LEED medal awards (there is LEED certification below this) and is based, in part, on credits such as close access to public transportation that even Building 20 would have received.

Stata does have a raised floor technology that permits the use of displacement ventilation to provide cool ventilated air. This does produce more comfortable conditions. In studies we did for several climates, the energy savings in chiller use with displacement ventilation was just about offset by increased fan power requirements for the higher flow rates that are required. In other words, there aren't any significant energy savings to be expected with this system. Similarly, there were excesses in material used in the building structure.

The faculty and students in the Building Technology Program at MIT have a number of sustainable building projects underway in China, the UK, and the U.S. We have shown that if properly integrated into the original design, sustainable technologies can have a minimal impact on initial cost and at the same time improve the quality of the indoor environment. It was our hope that MIT could be a leader in demonstrating realistic cost-effect designs that produce extraordinary savings in CO2 production, nonrenewable materials conservation, and other important factors. Although there was a declaration at the outset to produce sustainable buildings in both the Stata and Simmons projects, the lead architects did not seriously consider sustainability measures. It is unfortunate that MIT has only achieved, at most, modest sustainability progress with the new buildings.

At the least, MIT needs to exercise some caution in our characterization of these projects. We would hope for future buildings that faculty and students emphasize the need to keep sustainability a major priority throughout the project.

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MIT Poetry

by Jean Monahan

Mauled Illusionist Goes Home

– Roy Horn, trainer and illusionist, attacked by his own white tiger at the Las Vegas Mirage hotel

True, I saw
It coming: my head's hot halo
In the steaming cavern,
The tiger's red tongue
Rolled like a boulder across
The opening, light leaving
For an instant and women grieving
Outside, desperate to unwrap
Me from death's swaddling:
That slaughter-of-innocents
We keep reading about, somewhere
So far off it has the quality of mirage
Until with our own eyes
We see through
Our invention and the scales
Fall. On a pall of teeth
I was hauled
From the glittering ring,
Beaten at my own game, tamed.
Off-stage, I healed
Myself, away from the crowds
Who pressed too close and loud,
Heart in mouth
For my throat in the maw,
My whip on the back
Of what we feed and love and pretend
Loves us back.

Witness

In the end, somebody always has to look.

No matter the risk, the worrying fear,
someone has to stand at the door,
seeing for herself what's there.

It was high morning and the gate
swung open and near. The heat was in her hair
and she could have done anything else but turn:
call to her husband and
daughters, swoon.

She could have used her
imagination but she chose instead to bear
witness to the things of this earth, evil or good.
Nameless, she stood watching
as the heavens fell
on Sodom's sleeping sinners, knowing herself
a neighbor to sin, if not a sinner. Nameless

because, according to the ancient code
a witness gives up her identity,
becomes the thing she witnesses,
because, by blameless witnessing,
blames us.

Jean Monahan, who teaches poetry part time in the Literature Section, has published two books of poems, *Believe It or Not* (Orchises Press) and *Hands*, winner of the 1991 Anhinga Prize *(jehane@mit.edu)*.

Research at MIT

Haystack Observatory

Joseph E. Salah

HAYSTACK OBSERVATORY IS A multidisciplinary research center engaged in radio astronomy, geodesy, and upper atmospheric physics. The Observatory's facilities are located off campus, on 1300 acres of hilly woodlands 40 miles northwest of Cambridge, in Westford, Massachusetts. The research programs and operations of the Observatory's radio telescopes and radars are conducted by a group of 100 research scientists, engineers, and technical personnel. Parts of Haystack's research programs are carried out in collaboration with faculty and staff on campus and at area universities which form the Northeast Radio Observatory Consortium (NEROC). Some of the facilities at the Observatory are shared with Lincoln Laboratory for its space surveillance program.

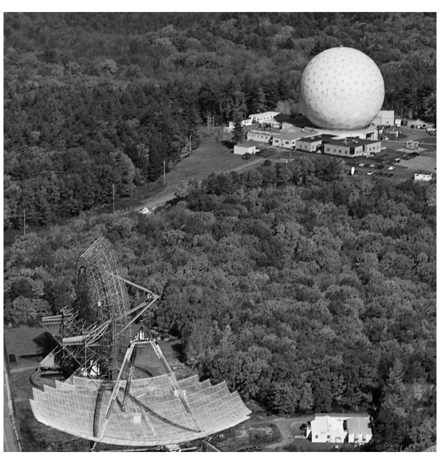

Figure 1. Photograph of primary Haystack Observatory radio antennas.

The primary Haystack Observatory observing instruments include a 37-meter diameter radio telescope and radar housed in the large dome (top of photo, Figure 1), a 67-meter zenith-pointed antenna, and a 45-meter steerable antenna (bottom of photo) that are part of the high-power Millstone Hill radar used to probe the Earth's upper atmosphere. A major upgrade of the 37-meter antenna is now being undertaken by Lincoln Laboratory to enable radar operations at 95 GHz for satellite imaging with fine resolution, and the upgrade is expected to benefit radio astronomical research in the future.

Current Research Emphasis

In the quest for higher sensitivity and higher resolution, radio astronomical observations have generally moved from single-dish apertures to arrays of antennas, and Haystack Observatory has been leading several of these developments. An array of 25 stations, each consisting of 24 dipole antennas and digital receivers tuned to 327 MHz, is under construction at Haystack to detect the emission line of deuterium. Deuterium is a sensitive indicator of the density of baryons that relates to the amount of dark matter in the universe. The array is nearly complete and deep integrations of this faint line, so far undetected by radio techniques due to the lack of adequate sensitivity, will begin later this year.

Design work for the first fully digital radio telescope – an array of low frequency dipole antennas covering 10 to 250 MHz – has been progressing with the expectation that a demonstrator system will be constructed in the next few years prior to the implementation of the full array of 100 stations, preferably in the outback of Western Australia, where radio frequency interference from man-made noise is very low. The project, a collaborative effort with the Center for Space Research, is aimed at characterizing the epoch of re-ionization during the formation of the early universe, detecting transients at radio frequencies such as from gamma-ray bursts and pulsars, and investigating various heliospheric phenomena, particularly the magnetic fields of plasma perturbations in the solar wind.

Haystack Observatory has also continued to advance the technology and application of Very Long Baseline Interferometry (VLBI), where global arrays of radio telescopes are linked together to yield high resolution images of galaxies and to study Earth's orientation parameters. Pioneering experiments at frequencies of 129 GHz and 230 GHz using telescopes in Arizona and Spain equipped with Haystack's new wideband recording technology, have resulted in the successful detection of interferometric fringes on extragalactic radio sources with a resolution of 34 micro-arcseconds – a world record! In addition, emission from silicon monoxide masers in high rotational transitions was imaged around several stellar sources, including the evolved star VYCMa as shown in Figure 2. The high excitation temperature required for this astronomical maser action places these masers very near the stellar surface, making them unique probes of kinematics at only a few stellar radii. A "line" of maser regions towards VYCMa is observed, suggesting that this high frequency transition may trace the innermost regions of a nearly edge-on circumstellar disk that is oriented in the

SE-NW direction. Such a disk has been hypothesized to be the cause of a well-known asymmetric reflection nebula surrounding the star.

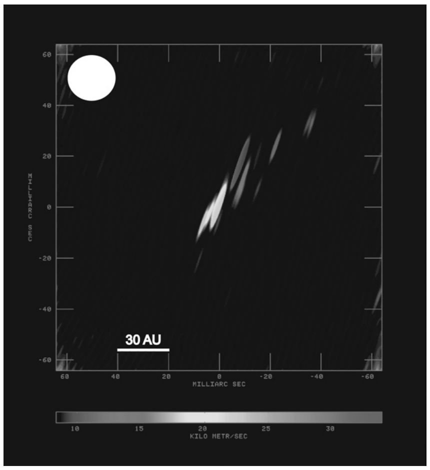

Figure 2. Map of SiO maser emission at 129 GHz towards the evolved star VYCMa, color coded according to Doppler velocity. The white disk shows the size of the stellar photosphere.

Technology advances in VLBI achieved by Haystack engineers have focused on the enhancement of the bandwidth of recorded signals to improve the sensitivity of astronomical and geodetic observations. These advances include the development of magnetic disk recording systems capable of recording at rates of 1 Gbit/s, that have now been implemented at telescopes worldwide, and the development of high-speed digital correlators to process the measurements. In an effort to eliminate all data recording, further expand the measurement bandwidth, and process measurements in near real time, the transport of data on commercial optical fiber networks is being exploited, and protocols for sharing these networks with other users are being developed in a collaborative project with researchers from the Laboratory for Computer Science. Recent successful tests from Haystack Observatory to Goddard Space Flight Center and the Onsala Space Observatory in Sweden, have demonstrated the feasibility of this approach.

The Haystack Observatory program in upper atmospheric physics is based on the measurement of incoherent radar backscatter from Earth's ionosphere to determine the plasma density, temperature and velocity at altitudes from 100 to 1000 km and across a wide latitude band to the north and south of the Observatory. Emphasis has been recently given to the investigation of the variation of these parameters as a result of geomagnetic storms caused by the impact of coronal mass ejections from the Sun on the Earth's magnetosphere. During such events, large enhancements of plasma temperature reaching several thousand degrees are observed, and are believed to be caused by Joule heating generated by intense electric fields that are measured to be in excess of 50 mV/m compared to a few mV/m during quiet conditions. During the disturbed conditions, energetic particles are driven into the inner magnetosphere, and these drive currents into the ionosphere at middle latitudes that result in the formation of a region of strong electric fields. Millstone Hill radar observations reveal the persistent nature of these fields which span the night sector equatorward of the auroral two-cell pattern, as illustrated in Figure 3. In addition, steep gradients in plasma density are detected at the peak altitude of the ionospheric layer causing serious propagation effects on satellite communication signals – effects that are part of what has been termed as "space weather."

Education and Outreach

Haystack's research programs and facilities offer excellent training opportunities for students and junior scientists, particularly in instrumentation development. Graduate students and post-doctoral researchers are supported under the various array development projects, and undergraduates participate in internships that provide them with valuable research experiences.

A special program is also conducted to introduce undergraduates to radio astronomy through the use of a small radio telescope and by remote access to the 37-meter radio telescope via the internet. The small radio telescope, consisting

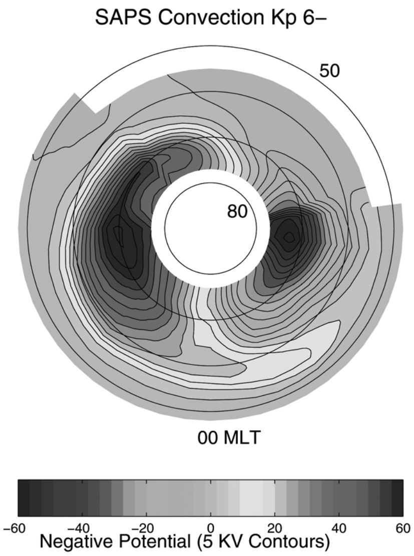

Figure 3. Equipotential contours of the auroral electric fields centered on the magnetic north pole and extending to 50º latitude, obtained from Millstone Hill radar observations.

of a two-meter antenna and a digital receiver, was developed at Haystack as a learning kit and has now been disseminated to about 80 colleges and universities nationally and internationally, together with special Web-based project materials.

As part of its outreach program to local area schools, Haystack Observatory supports summer internships for science teachers, and its staff members mentor high school students and interact with the neighboring communities through public lectures, tours of the facility, museum exhibits, and visits to classrooms. We welcome visits by MIT faculty, staff, and students to the Haystack Observatory at any time, and further information on our programs and facilities can be found at ***http://www.haystack.mit.edu.***

Joseph E. Salah is Director of the Haystack Observatory *(jsalah@haystack.mit.edu).*

Leadership, Management, and Education
Eagar, from page 1

test scores. Our faculty is distinguished; but again, several other schools have faculty who are our equal or better depending on the various yardsticks used. There must be some distinguishing attributes of MIT that cause others to look to us for leadership. We should determine what these attributes are, and we should nurture and cherish these as our fundamental strengths.

Over the past decade I have identified five distinguishing qualities which make MIT unique.

1. MIT has one class of students/faculty
2. MIT is intense
3. MIT has a culture of creativity
4. MIT has unusual breadth for an Institute of Technology
5. MIT displays integrity

1. One class of students/faculty

MIT admits only one class of students: scholars. Other elite schools proudly note that they admit three classes of students: scholars, athletes, and "legacy" students. MIT gives no honorary degrees; anyone with a degree from MIT has earned it. Only MIT and Caltech can claim such "purity" of scholarship among their alumni. The world equates admission to MIT or Caltech as certification of "genius" status. The MIT undergraduates are in the top 3/10,000 of the populace in native intelligence and our graduate students are a factor of five more select.

Equally so, the faculty are exceptional in scholarly abilities; in part because MIT confers tenure not just at the School level, but at the Academic Council level as well. At other schools a weak dean can tenure some marginal faculty who will become a drag upon the School for the next 30 years. Although MIT's Academic Council is an expensive use of administrative resources, it provides an extra quality filter on faculty promotions that is often lacking at other universities.

2. MIT is intense

When Paul Gray stepped down as president of MIT, he stated that one of his disappointments was that he had not been able to reduce the "pace and pressure" of the Institute. For many of us, this intensity is part of the essence of MIT. As a young faculty member, I met a distinguished engineering professor from another school at a technical conference. When he saw "MIT" on my name badge, he said, "MIT has the highest thermodynamic temperature in the universe. It's a great place to visit for a few days, but how do you stand it all the time?" Dick Simmons (namesake of Simmons Hall and an MIT Corporation member) says that "MIT taught me to work hard." I tell students that "MIT will take you to your limit – whatever it is." But MIT is a "no praise" zone.

When I presented these latter quotes to Professor Bob Brown as he became dean of Engineering, suggesting that as a leader he should praise the students and faculty more, Bob responded "the MIT faculty and students are reasonably bright, but insecure. That's why they work so hard. If they received praise, they wouldn't be so insecure and would not feel the need to work so hard." Working hard and learning to fail is a good experience, but failing to praise one another is a harmful by-product of our intense culture. As Pogo Possum said, "We have met the enemy and he is us." We need to remember that 90 percent of the pressure on both students and faculty at MIT is self-inflicted. It would not diminish our culture if we learned to praise one another more often.

One valuable by-product of the intensity of an MIT education is the opportunity to fail. Most of our students never experienced academic failure prior to coming to MIT. It was a shock for me as a student to experience a class average of 60 on an exam, but it was an even greater shock personally to be 30 points below class average. It is good to learn humility early in life, especially if it occurs in an environment where the long-term consequences of failure are not great. We should explicitly acknowledge that a purpose of an MIT education is to learn humility through the opportunity to fail. At MIT, every person learns that they cannot be the best at everything. We learn to respect the abilities of others.

3. MIT has a culture of creativity

A senior executive once asked Professor Ed Schein, "What is the difference between the MIT Sloan School and the Harvard Business School?" Ed replied, "Harvard is like the West Point of Business Schools; whereas the Sloan School is sort of the Bell Labs." Ed also notes that "MIT is an iconoclastic society." As a student at MIT, I learned to question the assumptions behind nearly everything I heard. This skill was not taught so much in the classroom, but came across strongly in my living group and in the research laboratory. MIT students and faculty delight not only in tearing down old images, but in creating new ways to view the world around us. It is a sport which tends to infect all of us; and it is a highly valuable and somewhat rare characteristic in the rest of the world.

4. MIT has unusual breadth for an Institute of Technology

We often repeat Jerry Wiesner's phrase that "MIT is a University polarized around science and technology." While this may be true, and our roots were certainly as an Institute of Technology, over the past half century MIT has broadened considerably. We may focus on technology, but we do far more than "just technology." The breadth of the scholarly pursuits at MIT never ceases to amaze me; I often say that "there is something at MIT for everyone." This is true in music, the arts, history, and many other fields, for which the general public does not often acknowledge MIT's participation, but in which fields MIT has significant scholarly leadership.

5. MIT displays integrity

When Chuck Vest announced that he would step down as president of MIT, Paul Gray and Dana Mead both used the word "integrity" to describe Chuck's tenure as president. In his essay on

"Twelve Qualities of a Leader" Norm Augustine (a member of the MIT Corporation) notes ". . . the worst of all worlds results when an individual endowed with other leadership qualities lacks the most fundamental quality of all: integrity." MIT has shown integrity in the past: when Paul Gray defended the education of international students before Congress; when MIT stood alone against the Department of Justice in defense of need-based financial aid; when Bob Birgeneau admitted that women faculty at MIT had not been treated equally; when MIT re-acknowledged the need for Institute involvement in the daily life of freshmen; and when MIT resisted numerous assaults on academic freedom, academic honesty, university accounting, merit based research funding, and free speech. We are not pure in each of these areas, but we have displayed much more integrity than many of our sister universities.

These are some of the reasons why the world holds MIT to a higher standard. We are acknowledged as intelligent, hard working, creative individuals working on a host of complex problems that affect the lives of the vast majority of people around the world. But most importantly, the public sees us as having integrity. The world wants to believe what we say. If we disappoint them, they judge us more harshly.

The True Value of an MIT Education

While the experiences of hard work, learning to fail and the resulting humility which that failure engenders are essential aspects of an MIT education, the true value of an MIT education is learning to learn independently. Perhaps it is due to the habit of questioning the hidden assumptions, or of quizzing students on topics found in the reading which were not covered in the lecture, but most MIT students learn how to educate themselves. As Robert M. Hutchins, former president of the University of Chicago, stated: "The object of a liberal education is not to teach the young all they will ever need to know. It is to give them the habits, ideas and techniques that they need to continue to educate themselves. Thus, the object of formal institutional liberal education in youth is to prepare the young to educate themselves throughout their lives." We subscribe to this philosophy at MIT, but we often fail to appreciate another maxim of Hutchins, viz. "The mind is not a receptacle; information is not education. Education is what remains after the information that has been taught has been forgotten." How often have I sat in faculty meetings where it is stated that "we must cover [such and such]; otherwise our students will not have what they need to succeed." Given that their quiz scores indicate that they only absorbed 60 percent on average of what we expected to have taught them; most of them succeed quite admirably, in spite of having a receptacle that is only 60 percent full.

In my opinion, the problem is that we do not engender a feeling of self-confidence in our students. One study, which the administration continually tries to downplay, reported that MIT seniors felt less confident when they graduated from MIT than they did when they entered as freshmen.

A Primary Deficiency of the MIT Education

A few years ago in *Tech Talk* an MIT student asked, "Why do MIT alums usually end up working for Yale and Harvard graduates?" In response, the article quoted Alan G. Spoon, an MIT alum and COO of *The Washington Post*, "I'm convinced that MIT's already large contribution to our society would sharply expand if its graduates were even better advocates and raconteurs for their views and labors." [Further emphasis on the need to teach students to communicate effectively.] In my opinion, the problem is that we do not engender a feeling of self-confidence in our students. One study, which the administration continually tries to downplay, reported that MIT seniors felt less confident when they graduated from MIT than they did when they entered as freshmen. This is hardly surprising. By admitting a class of only exceptional scholars, MIT students live for four years in an unnatural environment. Forty-five percent of our freshmen were valedictorians in their high schools. They learned to compare themselves with their peers based on academics, because they always came out at the top. But when students enter MIT, they quickly learn that "on average they are average." It is a cultural shock. Most students soon learn to compare themselves with themselves rather than with others, and they learn to work hard; to reach the limit of their abilities. This is a valuable lesson; but we must remind them often that the MIT environment is not reality.

In reality they are the top 3/10,000 and they should leave MIT with the knowledge that they are not just average; they are the best. They should believe that it is their destiny to lead the world. I do not believe we praise them enough or remind them enough that they are truly exceptional. As a result, they must relearn their intellectual rank in society after they leave MIT. I believe we can challenge them, teach them to work hard and to feel good about themselves at the same time. As F. Scott Fitzgerald said, "The test of a first-rate intelligence is the ability to hold two opposed ideas in the mind at the same time, and still retain the ability to function." MIT students (and faculty) are first-rate intelligences and they can understand that they are the best; while learning that there is much that they do not understand. We must learn to embrace the contributions of others, both within MIT and outside MIT. Our students (and faculty) need to improve their skills of interaction, learn to depend on and trust others, and work as part of a team.

MIT Leadership and MIT Management

While the world looks to MIT for leadership, we look within MIT for our own

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Leadership, Management, and Education
Eagar, from preceding page

leaders. There are many types of leaders. Thousands of years ago, Lao Tsu noted: "The wicked leader is he who the people despise; the good leader is he who the people revere; the great leader is he who the people say, 'we did it ourselves.'"

As Norm Augustine noted, "True leaders motivate people to pursue worthwhile and lofty objectives." With faculty and students of the caliber of MIT, true leadership should not be difficult to find; but management is often mistaken for leadership.

As Admiral Grace Hopper said, "No one ever managed men into battle." As an example of the conflict between leadership and management, I remember as a young professor, my contract officer in the Office of Sponsored Programs was particularly helpful in negotiating a significant new contract. Out of gratitude, I wrote a letter to his supervisor outlining my pleasure with his service. A few months later, in a conversation, I told him that I had written a letter of appreciation for his help. He told me that he had seen the letter; his manager had turned it into a letter of condemnation with the statement "your job is not to help the faculty; your job is to control the faculty." This anecdote illustrates the difference between a leader and a manager. "A leader seeks to help others; a manager seeks to control others." This difference was reinforced by Hugh W. Nibley in a commencement address at another university over 20 years ago entitled "Leaders to Managers: The Fatal Shift."

"The Generalstab tried desperately for a hundred years to train up a generation of leaders for the German Army; but it never worked, because the men who delighted their superiors; i.e. the managers, got the high commands, while the men who delighted the lower ranks, i.e. the leaders, got reprimands . . . . Leaders are movers and shakers, original, inventive, unpredictable, imaginative, full of surprises that discomfit the enemy in war and the main office in peace. For the managers are safe, conservative, predictable, conforming organization men and team players, dedicated to the establishment. The leader, for example, has a passion for equality. . . . For the manager, the idea of equality is repugnant and even counterproductive. When promotion, perks, privilege, and power are the name of the game, awe and reverence for rank is everything, . . . In short, while management shuns equality, it feeds on mediocrity. On the other hand, leadership is an escape from mediocrity. The leader being simply the one who sets the highest example. . . . True leaders are inspiring because they are inspired, caught up in a higher purpose, devoid of personal ambition, idealistic, and incorruptible."

From Nibley's insights I determined that the primary problem with Business Schools is that they teach management or control of others, rather than true leadership, which involves service to others. I also learned that one can determine whether one should work for a company even before walking through the doors: just look for the number of assigned spaces in the parking lot. It is interesting how such a simple concept generates agreement among my friends in industry. [I would note that the number of reserved parking spaces for the MIT administration has grown from two to five in the past 10 years.]

Conclusion

When summarizing leadership for my students, I use the following six points:

A Leader:
- Gets the Right Things Done
- Does More Than is Required
- Balances Professional and Personal Responsibilities
- Respects the Contributions of Everyone
- Contributes to the Community
- Follows Others When Not Leading

The first is from Peter Drucker, who notes that leaders not only get things done, but they spend their time on the "right" things. Two other points deserve special note. Students (and faculty) need to understand the need to balance their professional and their personal lives. I have met many people who could not function effectively at work because they had so many problems at home. If one cannot lead one's spouse and children and help them find satisfaction and happiness, it is unlikely that one can lay the foundation for true leadership at work. The second item of special note is respect for the contributions of everyone. Everyone at MIT can contribute to the strength of the Institute, whether their job be great or humble in the eyes of others. In fact, the groups whose efforts are most immediately noticed if left undone are the custodial staff and the food service staff. Without their efforts, MIT would be a much less pleasant place to work; yet we rarely praise or acknowledge these people.

As MIT searches for a new president, we should require our next leader to exemplify the same levels of integrity and leadership as our previous leaders. We should use this time of change as an opportunity to reflect on what makes MIT unique; what can be changed without sacrificing what has made us unique. Our mission is education, and as David O. McKay once summarized: "Character is the aim of true education . . . and science, history, and literature are but means used to accomplish this desired end. True education seeks to make men and women not only good mathematicians, proficient linguists, profound scientists, or brilliant literary lights, but also honest people with virtue, temperance, and brotherly love. It seeks to make men and women who prize truth, justice, wisdom, benevolence, and self-control as the choicest acquisitions of a successful life." Moving forward, we need to focus on these fundamentals. If we do, the rest will take care of itself.

Thomas W. Eagar is a Professor of Materials Engineering and Engineering Systems *(tweagar@mit.edu)*.

The Changing Environment of Scholarly Communication: Challenges and Opportunities for Faculty

Ann J. Wolpert
Markus Zahn

THE FACULTY COMMITTEE ON the Library System has been monitoring changes in the pricing and distribution business practices of scholarly journals for the past several years. A number of these changes threaten the ability of the MIT Libraries to adequately serve the education and research needs of MIT students and faculty. Of particular concern are the costs of print and electronic journals, and the increasingly constrained contract terms under which digital access may be licensed. This article is intended both to inform faculty and to request support in addressing an issue critical to the entire MIT community.

In the December/January 2003 issue of the *Faculty Newsletter* [***https://web.mit.edu/fnl/vol/archives/fnl153.pdf***] we alerted you to several particularly disturbing trends, including product bundling and licensing strategies developed by publishers with the intent of retaining market share. These content licensing practices require libraries to maintain an annually inflated level of expenditure with a given publisher, or else lose access to a significantly greater number of titles than would have been the case under a purchased subscription model.

Underlying and exacerbating the constraints of this licensing environment are the continuing rapid price increases for science, technology, and medical/biomedical (STM) journals. Many faculty do not realize just how expensive scholarly journals have become. Over the past decade, increases for the MIT Libraries' subscriptions have averaged approximately 8% per year, compounded – a rate that far outpaces the Consumer Price Index.

Fiscal pressures on universities and libraries in the last few years have made the need for change in the system of scholarly publishing more visible and urgent. Unable to pay for increasingly expensive content, and working within the confines of licenses that dictate problematic terms of use and impose penalties for cancellations, all academic libraries are finding it increasingly difficult to balance the needs of faculty and students across the disciplines on their campuses.

For many years, society's support for research universities has rested on the assumption that the output of research universities will benefit society. It follows that publication of research results should likewise be readily available to others. Yet, the scholarly publishing system is dominated by large commercial and society publishers whose primary obligation is to their shareholders and members, not faculty and students. The price increases and pricing structures imposed by these publishers have the effect of narrowing the selection of information sources available to the entire academy. To change this system will require broad, cumulative change. There is encouraging evidence that this change is beginning.

One such change is the "open access" movement, a strategy that has attracted the interest of many disciplines. The philosophy behind this movement was defined in the Budapest Open Access Initiative of 2002: ***http://www.soros.org/openaccess/read.shtml***, signed by hundreds of individuals and academic and scientific organizations throughout the world. The Initiative recommends two approaches to providing open access to the research literature: (1) open access journals, and (2) institutional or individual self-archiving in digital repositories.

Open access proposes a new method of distribution of scholarly information for journals, one in which access would be free to all readers worldwide. Any costs for editorial review and production would be paid for by mechanisms (e.g., page charges) other than personal or library subscriptions.

The Public Library of Science (PLoS) is perhaps the most visible example of this approach to journal publishing in that it publishes high-quality, peer-reviewed open access journals. PloS is an organization of scientists and physicians committed to making scientific and medical literature freely available on the Internet. PLoS has attracted eminent editors and outstanding submissions for its first journal, PloS Biology, and several additional journals are planned. A multilayered funding program supports PLoS efforts: grant funding, processing fees from authors, and institutional memberships. Another example of an open access publisher is BioMed Central, established in May 2000.

Institutional digital repositories, such as the MIT Libraries' DSpace, provide another avenue for open access to the research literature. The sidebar to this article documents the Libraries' plans to make it even easier for faculty to contribute their articles and other research publications to DSpace, where they can be immediately available, indexed by search engines such as Google, and preserved indefinitely. Faculty also can take advantage of Creative Commons licenses when

The Changing Environment of Scholarly Education
Wolpert and Zahn, from preceding page

contributing to DSpace. The DSpace software is available for free under a BSD (Open Source) license, and it has been downloaded by thousands of institutions and organizations, worldwide. Dozens of MIT's peer institutions are now establishing digital repositories using DSpace and other software environments.

Institutional repositories and open access journals are both important new developments in the search for solutions to over-priced, usage-constrained scholarly journals. Together, these initiatives illuminate the base-line costs of reviewing, preparing, disseminating, and preserving research output, and they permit the research community to experiment with new business models. These and other initiatives have the potential to provide viable alternatives to a scholarly research publishing system that has become even more problematic in the digital environment.

What can you do as an individual to contribute to change in the system? We encourage you to consider the following actions:

- place copies of your research papers and related material in DSpace
- publish in and review for journals that are open access or reasonably priced
- sign agreements with publishers that enable you to retain rights to the content of articles and books you publish
- consider alternative publishers for a journal you edit, if you do not agree with the current publisher's business practices
- become familiar with your society's publishing program, and be an advocate for change if it is warranted.

What can academic research libraries do? Last year (FY04), faced with reduced or constrained library budgets, many libraries took steps to regain control over selection and cancellation decisions in their serials lists. Libraries at Duke, Cornell, Harvard, and the University of North Carolina all revised their license terms with major commercial publishers and refused contracts that would have locked them into obligatory, annually inflating spending rates. In each case, due to the licensing terms established by the publishers, these libraries were required to substantially reduce their titles in order to realize budget savings.

While the MIT Libraries did not experience serials budget reductions in FY04, they declined three-year contracts with both Elsevier Science and Wiley InterScience due to uncertainties about FY05 funding. Now, with less than full inflation funding for FY05, MIT Libraries are planning to take the same action as these colleague institutions did last year. Elsevier Science subscriptions account for approximately 27% ($1,537,000) of MIT's serial subscription funds but provide less than 15% (769) of journal titles. It would be unreasonable for the Libraries to protect Elsevier titles at the expense of the remaining 85% of journals that support the broad academic interests of our community.

The cancellations needed to adjust the relationship with Elsevier this year are likely to be extended to other large commercial publishers in the coming years. The Libraries' obligation in making this change, is to support all education and research programs at MIT fairly, regardless of which publishers support what academic disciplines. The Faculty Committee on the Library System supports the Libraries' difficult decision to cancel some subscriptions. We are hopeful that if other prestigious libraries follow suit, it will contribute to change in the larger system of scholarly communication.

Early last month, a memo was sent to the academic department heads describing the situation the Libraries face and the planned action. Librarians with selection responsibilities are currently gathering price, usage, and impact factor data and soliciting input from departmental liaisons to guide decisions. The Libraries very much appreciate the support and assistance of faculty. ■

Ann J. Wolpert is Director of Libraries *(awolpert@mit.edu).* **Markus Zahn** is a Professor of Electrical Engineering *(zahn@mit.edu).*

DSpace – An Option for Faculty

MIT faculty have access to DSpace [*http://dspace.mit.edu*], a digital repository hosted by the MIT Libraries as a service. DSpace enables faculty to deposit their work in a professionally managed repository that both makes the work available and preserves it. Authors are not required to relinquish their copyright in order to use DSpace.

Faculty can create their own digital collections in DSpace. Collections can include preprints, published articles, images, collections of course materials, datasets and any other digital materials created during the research and teaching process.

Benefits of DSpace:

- **Worldwide visibility**
- **Subscription feature alerts users of new work**
- **More frequently indexed by Google**
- **All work centrally available and preserved over time**
- **Rapid distribution of research results**
- **"Persistent" URL to cite work**
- **Support for non-text formats such as image and video**
- **Fulfills funding agencies' requirements for research data dissemination and preservation**

To start your collection in DSpace:
Contact Margret Branschofsky at *margretb@mit.edu* or 3-1293.

Security on the MIT Campus

John DiFava

Director of Security and Campus Police Services John DiFava responds to concerns posed by the Faculty Newsletter.

Attitude changes since 9/11/01

SINCE THE TERRORIST ATTACKS, there has been an important shift in people's attitudes toward security measures, because the need for them is much clearer now. Before, people were less willing to put up with the inconvenience that some security procedures can require. Another difference I've noticed is that people realize that security is not just the job of uniformed professionals. Instead, everyone must take some responsibility for security.

Here at MIT, community members are very interested in security issues, and that attention seems to be growing. My goal for our campus is to provide the appropriate levels of protection in ways that have as little impact as possible on people's freedom.

In Building 18, for example, we had a sort of "town meeting" with the people who work there, and I think that once they understood the philosophy behind the security measures, they were pretty willing to go along with them.

Does MIT's research make us a target?

Some community members have wondered whether the types of research that are conducted on our campus are likely to make MIT a target of a terrorist attack. Terrorism is certainly about making a statement. So, my feeling is that any place that does research and also is as high profile an institution as MIT could potentially be a target. However, it's important to note that there have been no particular, specific threats toward the Institute.

I have assigned one of the MIT Police lieutenants to spend a significant portion of his time reviewing information from federal, state, and local governments about terrorist activities that they are tracking. This keeps us current and connected to what's going on beyond our campus.

Security changes planned for the campus

A major change is that we're approaching security at MIT in a more comprehensive manner. A lot of improvements had already been made, but the key as we go forward is to coordinate those efforts. That's a major part of my job, and I'll be emphasizing system interoperability and integration.

In addition, I'm looking at the campus area by area, because there are some locations where it's easy to tighten up access without causing undue inconvenience. For example, MIT's Central Utilities Plant is relatively easy to make more secure because only people who need to be there should have access to the building. That's probably true in other locations as well.

Another way to increase both security and people's perception of being safe is to improve lighting. And, working with the Department of Facilities, we are tackling lighting issues both within and outside campus buildings.

The budget

I'm pleased to tell you that the budget for the MIT Police was not cut for fiscal year 2004. In addition, I will have a budget of $500,000 for implementing new security measures. In order to determine how best to utilize these resources, I'm creating two committees that will advise me. The first is called the Institute Security Advisory Board, and its members will suggest security measures that still are needed. The other, the Security Working Group, will help to put those ideas into operation.

Personal safety in labs

Faculty members and some graduate students have told me that they are concerned about safety when they need to work at odd hours in their labs. First, I should note that there is now more coverage of the campus by MIT officers on foot patrol. Another improvement is that we are interacting more with the Cambridge Police Department to acquire their crime data. If that data and mapping information show activity near our campus, we respond appropriately.

In addition, there are specific things that researchers can do to increase their sense of security – especially if they're working at unusual hours. One is to call the MIT Police to discuss the situation. For example, an officer can make a "well-being" check at the lab. Also, we can escort a researcher to his or her vehicle when they're ready to leave the lab.

In response to a question about whether there have been many break-ins to our labs, I can tell you that in the 27 months I've worked at MIT, there has been only one forced break-in, and that was into an office. The other "break-ins" were by people who had keys or card access to the areas.

The presence of uniformed officers

There's no question that the presence of uniformed officers makes people feel safer, and that's part of the reason that you now see more MIT cops patrolling on campus.

Safety in MIT's parking garages

In my view, there's some risk in any kind of parking area. That's why I've increased the MIT Police presence in our garages with both motorcycle and cruiser patrols on a frequent basis. The availability of emergency phones is also important to increase the community's sense of safety in the garages (and elsewhere on campus).

Feedback

If faculty members have other concerns that haven't been addressed in this article, I would welcome hearing from them. ■

John DiFava is Director of Security and Campus Police Services *(jdifava@mit.edu)*.

OpenCourseWare Update

Beyond the Anecdotes

Steven R. Lerman

The world responds to MIT's OpenCourseWare

WHEN MIT FIRST ANNOUNCED OpenCourseWare in April 2001, it was just an idea – an informed leap of faith that it would be the right thing to do and that it would advance education. No university had ever done anything quite like it, and so we could only speculate on what the world might do with the educational materials we decided to make freely available.

Through the first year or so of the MIT OpenCourseWare (MIT OCW) operation, we were encouraged by the volume of laudatory feedback from users around the world. Now we are beginning to learn what OCW really means.

Just after its fall 2003 "official launch," publishing the first 506 courses for public access on the Web, MIT began a rigorous data collection process to find out who is accessing MIT OCW, why and how they use it, and what difference the initiative makes. The results of this first baseline evaluation confirm what we have heard anecdotally from more than 15,000 e-mails since the original pilot Web site of 32 courses was opened to the public in fall 2002: that educators, students, and self-learners around the world are using our course materials, and that, overwhelmingly, they find the materials useful in meeting their own learning and teaching goals.

The evaluation of MIT OCW integrates a variety of quantitative and qualitative methodologies and data sources: Web analytics are technical tools that capture site traffic data, geographic origin of visits, click patterns, and several other metrics. Most of these tools are in permanent operation, measuring activity on the MIT OCW Web site around the clock. During a two-week period in November 2003, MIT OCW asked about one in 40 visitors to participate in an online intercept survey, resulting in about 21,500 solicitations with a 5.7% response rate. These surveys asked visitors to profile themselves, indicate how they use MIT OCW materials, what they expected to get out of it, and their success in achieving their objectives. The MIT OCW conducted supplemental surveys and in-depth interviews with smaller samples to probe more deeply into the nature of their use.

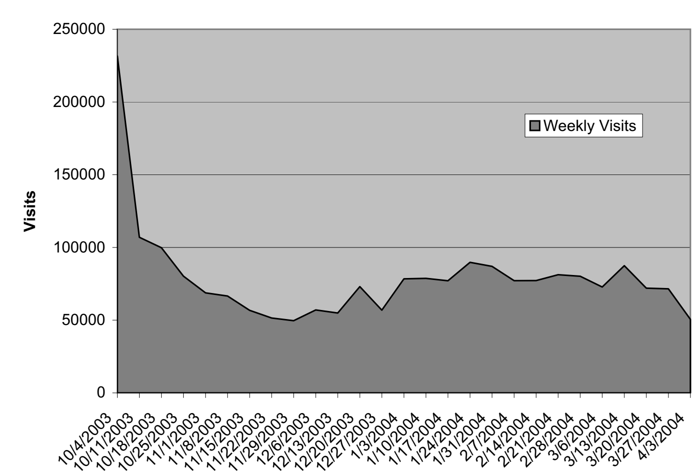
Who is accessing MIT OCW?

On average, MIT OCW clocks over 11,000 visits per day, with nearly a quarter-million unique visitors per month. About 45% of these visitors come from the United States and Canada. Outside North America, the top countries of origin are China, the United Kingdom, Germany, India, Brazil, and Japan. In total, about 52% of visitors identify themselves as "self-learners," 31% as "students" enrolled in a formal course of study, and 13% as "educators." Assuming our survey respondents are representative of the population of MIT OCW users at-large, approximately 90,000 educators visited the MIT OCW Web site between October 1 and November 30, 2003.

We view educators as a particularly important target audience, because it is through them that MIT course materials can touch the greatest number of people and have the most profound impact on education around the world. Interestingly, while the overall proportion of educator visits is 13%, the proportion of educators from outside North America is higher, about 17%. About 55% of educators profile themselves as teaching in four-year colleges or universities, another 18% in graduate or professional schools, and 8% in two-year or junior college programs. Nearly half of all educators using MIT OCW have less than five years teaching experience.

Why and how are they using it?

MIT OCW asked visitors their primary purpose in using MIT course materials. Again focusing on educators, about 57% answered that they use it for course or curriculum development, 33% to enhance their subject matter understanding or support their research, and 7% for student advising. The most fre-



quently cited subject areas are electrical engineering and computer science, mathematics, and business/management. Elements of MIT course materials have been adopted or adapted for classroom use by 47% of educators, and another 41% are considering it.

Role	Extremely Positive Impact	Positive Impact	Moderately Positive Impact	Somewhat Positive Impact	No Positive Impact	TOTAL
Educators	29.7%	50.6%	10.1%	8.2%	1.3%	100.0%
Student	35.4%	48.0%	11.8%	3.8%	1.1%	100.0%
Self-learner	41.4%	43.4%	9.9%	3.8%	1.4%	100.0%

What difference does it make?

About 45% of educators indicate they were completely successful, and another 43% somewhat successful, in achieving their purpose when visiting MIT OCW. In the category of developing or planning a course, 74% of educators found MIT OCW materials useful or extremely useful. Over 97% of educators expressed satisfaction with the quality of the course materials published on the MIT OCW Web site, although anecdotal indications are that educators are more interested in the course structure and materials such as reference lists, exercises, and exams. About 76% agreed that MIT OCW will impact their future teaching practices, and nearly 99% believe that MIT OCW will have a positive impact on education overall.

These results are very gratifying, and demonstrate the profound impact we are having through the sharing of our course materials. Even in its early stages, MIT OCW is becoming an important educational resource. As of April 1, there are now 701 courses available, representing contributed materials from nearly half of our faculty. Moreover, while we continue publishing courses here at home, we have also begun talking with several other institutions that are interested in following in our footsteps, and some others are developing translations of some of the materials from MIT into their own languages. Our over-arching vision is that MIT's commitment to MIT OCW will be the start of a global movement in which faculty around the world create a body of educational materials that we all can draw upon in our teaching.

The full version (90 pages), and a summary version (14 pages), of the OpenCourseWare Program Evaluation Findings Report (March 2004) are available online at ***http://ocw.mit.edu/OcwWeb/Global/AboutOCW/evaluation.htm***. If you would like to participate in MIT OCW, please contact Jon Paul Potts, the MIT OCW communications manager, at *jpotts@mit.edu* or 2-3621. ■

Steven R. Lerman is a Professor of Civil and Environmental Engineering; Chair, OCW Faculty Advisory Board *(lerman@mit.edu)*.

My Experience with the Artist-in-Residence Program

Erik D. Demaine

BACK IN NOVEMBER I had the pleasure of hosting sculptor/mathematician/computer scientist George W. Hart through the MIT Office of the Arts' Artist-in-Residence Program. This article describes my experiences with both this residence in particular and the residency program in general.

George Hart is a research professor in computer science at SUNY Stony Brook. His sculpture involves the interplay between art and mathematics, particularly in the context of geometry. During his week-long residence, George gave two excellent talks, the first for a general audience and the second for those interested in the algorithms and mathematics behind his sculpture. Then came the most exciting part of the residency: group assembly of a new sculpture.

The group assembly involved about 50 people from the MIT community, largely students, holding on to 30 pieces of laser-cut wood and trying to arrange the pieces into a symmetric 30-inch ball of interlocking pieces. Beforehand, everyone built their own six-inch paper model of the same sculpture to build intuition about the form. It was an exciting three-hour event that challenged the geometric insight of many of the students. Overall I think the residence served as a good illustration of the exciting connections between art and mathematics.

The Artist-in-Residence Program co-supports many such residencies, enabling professional artists in all disciplines to work with MIT students and faculty in both curricular and co-curricular settings. Residencies range from three days to a semester. George Hart's residency was department-based, meaning that I shared the costs through my own grant. The deadline for the next round of applications will be in February 2005. I encourage you to apply!

For more information, see ***http://web.mit.edu/arts/special_programs/air/app.html*** (Artist-in-Residence Program) and ***http://theory.lcs.mit.edu/GeorgeHart/*** (George Hart's residency). ■

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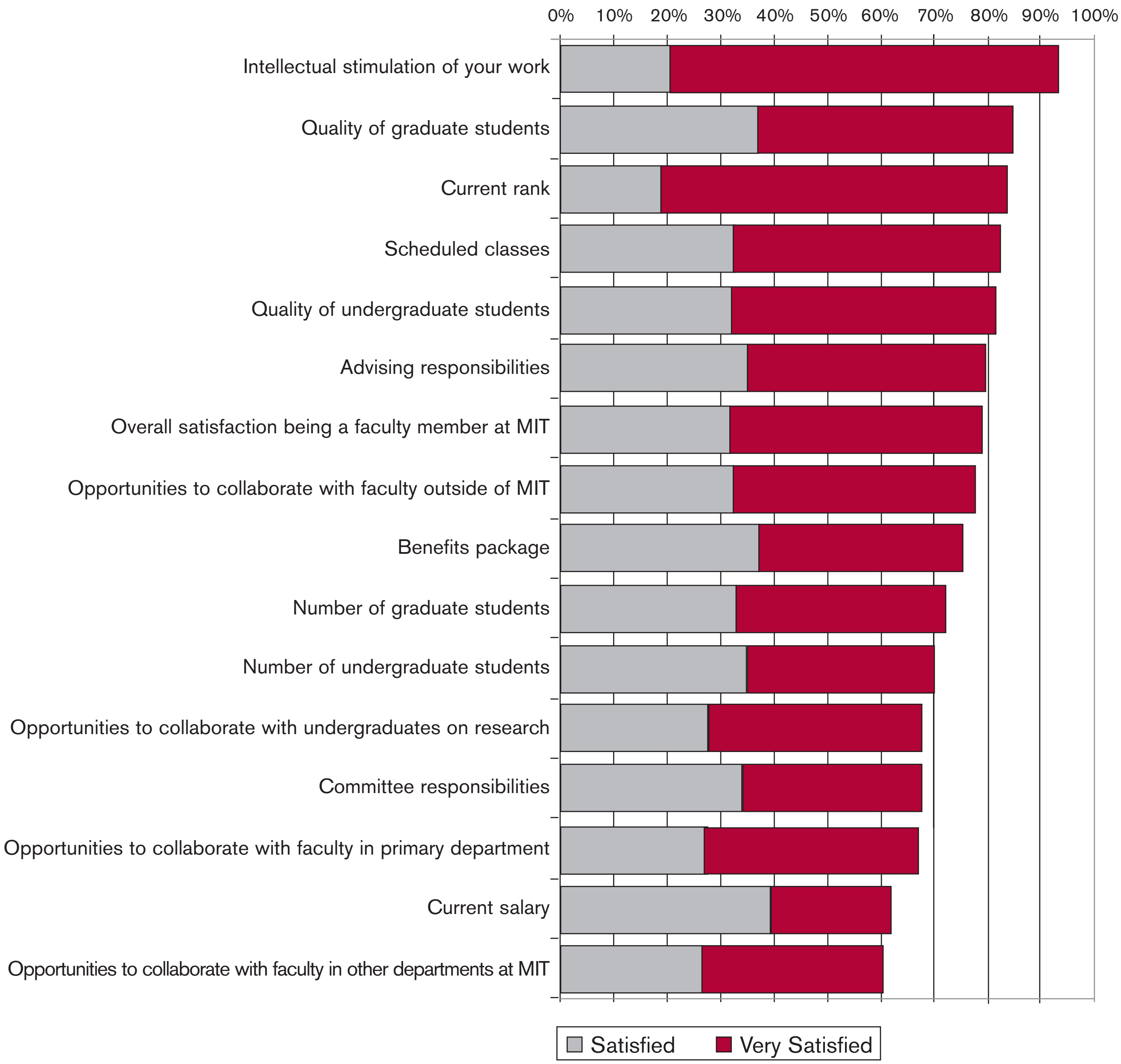
MIT Numbers

Faculty Satisfaction

[from the Faculty Survey 2004*]



*Preliminary analysis of the faculty survey administered by the Office of the Provost, Institutional Research in spring 2004.

Source: Office of the Provost