# The MIT Faculty Newsletter

## Preliminary Results from the Faculty Survey on Factors Which Influence Retirement Decisions
### R. John Hansman

### Introduction

As a result of the Age Discrimination in Employment Act (ADEA), mandatory retirement for faculty has been eliminated at all U.S. universities effective January 1995. The Committee on Faculty/Administration has been asked to study issues related to the evolving terms of employment of older faculty in the wake of this change.

As part of this effort, the committee conducted the *Faculty Survey on Factors Which Influence Retirement Decisions*. The survey assesses those factors which influence individual faculty decisions on retirement or change of status from full-time tenured positions. It shall be noted that this survey did *not* address the financial structure of the MIT retirement plans but rather other factors which influence retirement decisions.

### Structure of the Survey

The survey consisted of five elements. The first requested demographic data of the respondents. The second element addressed planning for retirement and

## Tough Times Ahead: A Graduate Student Perspective
### Bonnie Souter
*Special to the Faculty Newsletter*

These are tough times for graduate study at MIT. With decreased federal spending, massive budget cuts in scientific programs, fewer government sponsored fellowships, and fiscal year 1998 coming up soon, the prospects for both currently enrolled graduate students and recent graduates are changing rapidly. These funding decreases mean fewer jobs in basic research. But what else do they mean, in terms of research and career prospects for Ph.D. students? How do graduate students feel about these prospects; what do they expect, and what do they want?

Now, I am not representative of all MIT graduate students, but I can try to answer these questions. I have not thoroughly surveyed all graduate students: I have only my own experience to draw from, plus the experiences of a few students I have discussed these issues with. This perspective is that of a Ph.D. student in science.

My impression is that many graduate students feel little concern yet about whether they will have adequate funding to finish. They trust their advisors to

## Mail Services Redesign Explained
### Dave Lambert

*In the October 1995 issue of* The MIT Faculty Newsletter, *Professor James Kirtley, Jr. authored a thoughtful article entitled "Penny Wise and Pound Foolish: Re-Engineering Reengineering." Many of his comments were directed at the changes to the mail system that were and still are being implemented. It is my hope that the following information from Dave Lambert, captain of the Mail Reengineering team, will help put the changes made to date into the larger perspective of what we are trying to accomplish overall. Before proceeding, however, I would like to openly acknowledge that during the first few months of the transition, timely distribution of mail seriously deteriorated. Following some staffing adjustments, delays in mail delivery service have been eliminated.*

**William R. Dickson**
**Senior Vice President**

When reviewing the effectiveness of the redesigned mail processes at MIT, it is necessary to understand both the past problems and the total set of goals established by the redesign team.

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## Editorial

# Ready, Fire, Aim: Reengineering Without a Target

Many of us, faculty, staff, and students alike, are facing changes – usually unpleasant – in our day to day professional lives and uncertainties – almost always unpleasant – in our longer term career plans that we neither bargained for nor expected. The academic/professional career trajectory is no longer subject to long range prediction. Our graduate students are particularly affected, as evidenced by this issue's Page 1 article, but we are all vulnerable. This institutional and personal turbulence is a result of the globalization of the economy and the continuing technological revolution in production and communication.

Change will not be stayed. Not only manufacturing and service institutions, but educational institutions across the nation are being buffeted. MIT is particularly vulnerable to the ongoing reconfiguration of national priorities, with reduced public investment in higher education [see Page 6] as well as deep cuts in funding for research and development.

There is no doubt that MIT will have to change if it is to survive. We cannot endure as a productive institution without adapting to external changes in the political, economic, and intellectual environments. We are concerned, however, that we have become so fixated on the process of change that we have lost sight of our goals. We have subscribed to the latest management fad – slogans and software and posters and titles and all – but we have not adapted it to the particular concerns and unique status of MIT. Although TQM has withered, reengineering is here and MIT has seized upon it. The problem is that reengineering is intended to ensure that a corporation survives as a profit-making entity, but so narrow a vision is totally inappropriate for MIT. Our goals are harder to define, and success is harder to measure. The simplistic tools and goals of reengineering are totally incorrect for our situation.

Reengineering at MIT is turning out to be a set of independent local optimizations, with dollars as the target variable. There is no reason to believe that this will lead to anything like a global optimum. We don't have a strategy but we do have a tool and, faut de mieux, we are wielding it. In the absence of a goal, many of our actions are likely to be doing more harm than good.

The Institute needs to develop a Goal State and a plan for getting to that state. Until that is done, we must take pains to ensure that we do not do more harm than good, in a panicked desire *to do something*.

In the absence of a comprehensive long-term plan, we have identified three short-term goals that should guide our immediate actions:

- protect our people
- protect our core missions
- resist the current devaluation of education and the intellect.

Reengineering is not the best way to reflect these short-term goals and may even, if we are not careful, render us unable to achieve our yet undetermined long-term goals. We will return to the theme of developing a top level goal in the next issue of the *Faculty Newsletter*, but for now we will look at the effect of reengineering on our short-term goals.

### The Process and the People

The insistent local theme of reengineering is: How can we do more with fewer people, less space, and less hardware. As reengineering progresses here at MIT, uncomfortable and unanswered questions arise. What happens to individuals who are downsized? How do we deal responsibly with the human side of our enterprise? Reengineering "magic" casts a spell of anxiety, depression, and doubt on those who are re-engineered out of a job. The Institute needs to allocate resources and procedures to aid those who will be forced to make this painful transition. The faculty needs to develop forums for explicitly speaking to the rising concerns of our students and staff.

Are there creative strategies for coping effectively with our institutional future that the philosophy and practice of reengineering blocks from view? Are there new career roles that our society will need but hasn't yet recognized at the institutional level? How do we monitor reengineering performance? Are the benchmarks for grading the achievements of our highly paid consultants and our reengineering teams in place now?

### Educational Missions

The reengineering proposals refer to maintaining "excellence" but fail to identify actual overall mission priorities. Thus the early retirement plan is an effort to significantly reduce the number of faculty, and the graduate program is to be downsized by at least 15-20 percent. The size of the undergraduate body is expected to remain the same. This implies a sharp reduction in the teaching staff/student ratio. We are concerned that in the pressure on departments and individuals to go after whatever sources of outside income are available, the core educational mission of training the students to solve the problems of the next generation will become increasingly vulnerable.

### The Future of Research and Education

As we tighten our belt, we have to make sure that we don't narrow our vision. Scientific and technical issues, once the concern of a select few, have become the property of the whole population. All women need to be aware of the discovery of genes whose functions influence the onset of breast cancer; all teenagers need to be aware of the danger of oil spills, the threat of ozone depletion, global warning, or perhaps sunburn; all adults need to grasp the extraordinary new powers available from telecommunications technology, CD-ROMS, interactive TV, fiber optic cables.

Those of us charged with educating the next generation have to lead the way in calling for an expansion of public investment in higher education – expansion in the fraction of the population who receive advanced education, expansion in the length of time over which is it available, and expansion of the understanding that education is no longer to be provided only for an elite.

We can't desert the ship simply because the tides have turned; they will turn again. We mustn't undermine the educating of our populace for the future, because we can't figure out how to survive and prosper in a complex and changing environment.

**Editorial Committee**

## From The Faculty Chair

# Rethinking the way we do business . . .

**Lawrence S. Bacow**

In the next semester, the Presidential Task Forces on Student Life and Student Learning will begin their work. The Task Force on Student Life will be charged with developing a ten-year plan for housing, dining, and campus activities for both graduates and undergraduates. The Task Force on Student Learning will look for ways to strengthen the integrative and synthetic skills of our students while also trying to identify opportunities to enhance their curiosity and self-confidence.

This is not the first time that the faculty have been called upon to participate in a major review of student life and learning. Our current undergraduate curriculum and residence system reflect the work of a few extraordinarily influential faculty groups: the 1949 Committee on the Educational Survey (the Lewis Commission), the 1964 Committee on Content Planning, and the 1973 Committee on Undergraduate Housing in the 1970s. Unfortunately, our more recent efforts at curriculum and housing reform have been less successful. During academic year 1988-89, separate committees were formed to consider changes to the freshman housing system and the first-year program. In each case, the committees were encouraged to think broadly. In each case, the committees produced thoughtful reports, and in each case, their recommendations had little, if any, effect.

Clearly, everyone loses when committees labor hard to bring about meaningful change only to see their recommendations fall on deaf ears, or worse, to be actively repudiated by the faculty, students, or the administration. When this happens, committee members may rightfully feel embittered by a process that does not adequately respect their work on behalf of the larger community. Perhaps more importantly, when the work of a group appointed to address an important issue is not acted upon, the underlying problems that prompted creation of the committee remain unresolved. Moreover, after one group has dulled its ax on a problem without result, it is difficult for others to muster enthusiasm to tackle the same problem again, regardless of how pressing the issue may be. Indeed, in recruiting faculty to serve on the Task Forces now being formed, Roz Williams and I are frequently being asked, "Is this for real?"

Last year, the President and the then dean for Undergraduate Education and Student Affairs asked me to chair a small working group to review past reports of committees charged with evaluating different aspects of student life at MIT. The working group included Karen Gleason, Bora Mikic, Jeff Shapiro, and Irene Tayler. We were asked to revisit the recommendations of prior committees to determine what we might learn before appointing another group to examine a similar set of issues. Given that the Presidential Task Forces are about to begin their work, I thought it might be useful to share our findings with the larger community. (Anyone who would like to see a copy of our full report should contact me at bacow@mit.edu.)

**Our standard way of doing business**

Ad hoc faculty committees follow predictable patterns for going about their business. A charge is drafted, usually by the President, the provost, or relevant dean. Faculty are recruited to the enterprise usually to ensure reasonable representation from all schools throughout the Institute. Typically, people are picked because they are thoughtful, good citizens who are likely to work well in a collaborative undertaking. Those with strong a priori positions on issues are rarely asked to serve. Student representatives are added, typically one or two graduate and undergraduates. Depending upon the nature of the task to be done, a few members of the administration may be named to the committee. Staff is assigned.

Once the committee is formed, it usually meets to review the charge and discuss what factual information needs to be gathered. Occasionally a committee will hold hearings or conduct surveys to gather additional community input. Often these sessions are poorly attended, either because people are busy, or because anything less than a specific proposal is unlikely to inspire a response. After

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**Rethinking the way
we do business . . .**
*Bacow, from preceding page*

assembly of the relevant information, a series of meetings is scheduled to discuss substantive issues. Usually the chair of the committee (with the assistance of the staff) will take responsibility for preparing a draft report. In many cases, the circulation of the draft represents the start of serious internal negotiations over

observed, "God is in the details."

Second, consensus on a committee is not the same as consensus within the larger MIT community. No matter how carefully individuals are selected, it is impossible to name a committee that fully represents all diverse interests on campus. Students, for example, are far

than simply being asked to write a report, these Task Forces are being charged with building a consensus for change. As a first task, they are being encouraged to develop a series of possible suggestions for reform for review by the larger community. It is important that these suggestions not be viewed as fully formed recommendations, but rather different approaches to improving the quality of the student experience at MIT. Indeed, it may be desirable for some of these approaches to be mutually exclusive. The purpose of this first task is to stimulate vigorous debate within the Institute, and to encourage others to come forward with suggestions for improving upon the work of Task Forces.

> **First, our committee processes often undervalue (or worse, ignore) problems of implementation. Those who serve on committees typically have no responsibility for implementing their recommendations... As a result, while we are great at diagnosing problems and prescribing reasoned solutions, we often ignore the process by which we move the Institute from status quo to desired end state.**

substance. The work product of the committee is the final report which typically represents consensus. At MIT, minority reports are rare. Once the report is communicated to the party issuing the charge, the work of the committee is done.

While the above process appears reasonable, and almost always produces consensus on committees, it also frequently fails to bring about meaningful change. Why? There are at least two explanations.

First, our committee processes often undervalue (or worse, ignore) problems of implementation. Those who serve on committees typically have no responsibility for implementing their recommendations. Moreover, they are usually totally removed from the process of allocating resources necessary to bring about change. As a result, while we are great at diagnosing problems and prescribing reasoned solutions, we often ignore the process by which we move the Institute from status quo to desired end state. As Mies van der Rohe once

from a homogeneous group. Having one or two students on a committee in no way ensures that "student views are represented." Similarly, our traditions of collegiality may actually discourage vigorous representation on committees. Having been appointed to serve on a committee, most members feel obliged to take a broader view of an issue than might be articulated by someone outside the process. Also, committee members often do not see it as their responsibility to actively solicit the views of colleagues in their school, or to keep different constituencies informed about the progress of committee deliberations. Thus we should not be surprised when the carefully crafted consensus of a small committee breaks down when subject to the parochial, and sometimes more sharply worded opinions of the broader community.

**A different approach**

The charge to the new Task Forces on Student Life and Student Learning represents a different approach. Rather

Second, the Task Forces are being asked to build a coalition for change that not only enjoys wide support and is sensitive to problems of implementation, but that also is realistic in light of our limited resources. To succeed at this second task, these groups will have to solicit the active participation of faculty and administrators who have major responsibility for residence life, the first year, and the GIRs. Broad student participation is critical. Thus, the work product of the Task Forces should be a consensus-building effort, not just another report to be read. Towards this end, the Task Forces will have to think creatively about how to engage the larger community. The recent work of the Student Services Reengineering Team provides an excellent model of how to solicit community input.

If the Task Forces are to succeed at bringing about meaningful change, they must spend at least as much time thinking about how to move the organization as they do about optimal steady states. The latter approach has failed more than once. Perhaps the time has come to risk new forms of error.❖

# Why is the Congress Cutting Funds For Higher Education?

Jonathan King

One common feature of the House, Senate, and Clinton budgets currently being debated in Washington is disinvestment in education. This takes many forms, the most visible being the cuts in federal grants and loans for higher education. More subtle forms are the cutbacks in overhead payments on research grants to colleges and universities, and direct cuts in R&D. These funds directly and indirectly support teaching laboratories, teaching assistants, libraries, and computer facilities. At MIT, this is resulting in a reduction of the number of graduate students by at least 15 percent, the largest change in 35 years [see MIT Numbers, Page 32]. These changes are only a beginning since the Gingrich faction is calling for eliminating the Department of Education entirely.

Similar efforts to cut support for colleges and universities are occurring at the state level; for example, New York Governor Pataki's effort to shrink Cornell and the SUNY system, in addition to New York City's CUNY. Governor Weld's appointment of John Silber, an avowed opponent of public education, and his selection of Senator Bulger as chancellor of the UMass system, represent similar directions in our own state.

The budget cuts are occurring in an environment of rapid scientific and technological advances. Reports from the National Academy of Sciences, Department of Labor, and the American Association for the Advancement of Science, to name just a few, all call for a new higher level of general education in this information age. In a world with the Internet, everyone needs basic literacy and computer skills. In a world of human gene transplants, every person needs to understand basic genetics and biochemistry. In a world with ozone holes in the upper atmosphere, everyone needs to understand what chlorinated hydrocarbons are.

Why then are our leaders pushing to cut federal funding for education, student loans, funding for libraries, community colleges, after school programs, continuing education? Why are they trying to reduce the number of Americans who can receive a college education? The public posture of striving to reduce the budget is certainly not the reason. The bloated $300 billion total military budget, which dwarfs civilian research and education budgets, remains untouched, and the proposed tax cuts for the wealthy worsen the deficit.

Many MIT faculty and administration are actively involved in the budget debate. My involvement has been as a representative of the Biophysical Society working with representatives of other professional societies to develop a national Consensus Budget for Biomedical Research, as a platform in preparation for the 1997 budget battle, organized by FASEB (Federation of American Societies for Experimental Biology). It seems essential that we be

able to answer the underlying question of why this attack on research and education is occurring at this time in the nation's history.

### Leaps In Productivity and Reduced Needs for Skilled Labor

Two underlying factors can be identified driving this sea change in education policy. The first lies in the changing needs of industry for a trained workforce. The applications of computers and robotics to production has sharply increased productivity, while reducing the number of trained workers needed. These consequences of the technological revolution are well

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described in recent books including *The Jobless Future* by Aranowitz and Difazio and *The End of Work* by Jeremy Rifkind. Anyone reading about the layoffs of thousands of computer scientists in New England realizes that there is currently no shortage in private industry of highly trained workers. Those of us who have students or postdocs in the academic job market know of the intense competition for full-time academic jobs. According to the IEEE the level of unemployment among electronic engineers is the highest in 25 years. The recent announcement of

## Why is the Congress Cutting Funds For Higher Education?

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AT&T's phasing out 40,000 more of their staff puts to rest any notion that these changes represented minor variations.

One hundred years ago, leaders of the machine tool industry in Massachusetts supported educational reformers calling for public education, including trigonometry. They needed skilled workers who could read blueprints and set up a drill press. Similarly, after WWII, the High Technology Council in Massachusetts supported the expansion of higher education in Massachusetts, to provide an adequate supply of computer scientists for their expanding industry.

Now that these technologies have been applied to production themselves, the need has disappeared; supporting higher education through taxes becomes a cost of production. In a globalized economy, the competition in Malaysia does not provide general education. As Noam Chomsky points out so clearly, the conditions that colonial policies and transnational corporations have long maintained abroad are now being brought home, and the corporate and financial interests – acting through their representative in Congress both nationally and locally – are actively trying to reduce the social costs of education, in part by sharply reducing the number of people receiving higher education.

Of course, there is an enormous amount of work to be done in rebuilding our infrastructure, cleaning up the environment, providing health care for all, raising our children, and developing the science and technology needed for the next wave of civilization. But the private sector is not investing in these areas of social need, limiting the number of paying jobs available, and the Congressional majority is moving to close down public investment as fast as possible.

This brings us to the second factor behind the policies being launched at the federal and state levels. As the standard of living continues to decline for a majority of Americans, their support for current economic and political relations is going to erode. People pushed out of the productive economy are likely, sooner or later, to resist. The more educated they are, the more likely they are to expect and demand to be able to share in the expanding technology and great wealth represented in our country. The 10 percent of the population that is being enriched by the Gingrich policies are not interested in seeing the educational levels of the majority increase. Thus, we see the shift to building prisons rather than schools, so clearly in evidence in California, where the prison construction budget now exceeds the schools construction budget.

### Higher Education for All

This is a period in history when we should be sharply increasing investment in education, and expanding our system to provide universal secondary and higher education. The computer and telecommunications revolution provides the mechanism for this to be a reality; no longer must one get to a big university library to access the particular forms of information. Increasingly, this information is becoming electronically available through the Internet. Unfortunately, the technology is being implemented as a way of laying off teachers, researchers, teaching assistants, and related workers. This is very different from using it to expand opportunities for education and to increase and enhance the capabilities of teachers and students.

It is important to note that the funds are available. The continuation of B-2 bomber programs, nuclear submarines, Stars Wars missile systems in a post-Cold War period represents enormous waste of public wealth. A 10 percent cut in this budget, and transfer to civilian research and education, would allow doubling of the NSF and NIH budgets.

From the beginning of the electronics and telecommunications revolution, it has been clear that these technologies opened new horizons for education and the absolute expansion of knowledge. The technology now exists and is in place to have accessible a great part of the entire body of human knowledge to every person on Earth. An individual with access to the Internet can access most of the world's bodies of knowledge with a click of a button. It is also true that the ability to reap these benefits requires advances in education about the technology, as well as ensuring access.

### Faculty Roles in the Defense of Education

There is a tendency, when the forces in control of the government and the media are calling for the downsizing of higher education, to be shy of calling for its expansion. If those of us charged with the education of the next generation are hesitant to call for a higher and broader level of education, who will lead this struggle? We have to articulate clearly the extraordinary possibilities that modern technology offers to society, if mobilized for social advancement, rather than private gain.

A century ago it was a radical idea to propose that all children should have the opportunity to attend and graduate from high school. Though we still have a tough fight to achieve this, we are at the stage of human history where every member of society needs access to a higher and continuing education; a level of education that will let them share fully in the world's knowledge, and develop their own skills and talents. We at MIT need to play our part in bringing this vision closer to reality.❖

# System Design and Management Program
## *A Program for Educating Future Leaders of Engineering*
### Edward F. Crawley and Thomas L. Magnanti

Beginning January 1997, the School of Engineering and the Sloan School of Management will offer a new joint degree program, the System Design and Management (SDM) Program, leading to the degree of Master of Science in Engineering and Management. This new program provides a Second Professional Degree focusing on systems engineering/ architecture and the conception and design of complex products and systems. Much like an MBA does for a business leader, the program intends to prepare engineering leaders for careers as the technically-grounded senior managers of their enterprises. The program has emerged from a six-year planning process, and is among the highest priority initiatives in the strategic plans of the two schools. To date, over 30 faculty have participated in its development.

### Scope and Objectives

In many industries, the development of products and systems has reached an unprecedented level of complexity, requiring the coordination of diverse teams of engineers and marketing, manufacturing, and other professionals with a broad range of expertise. Mounting global competition and rising costs have added new challenges, demanding a faster and more efficient development process.

The new System Design and Management Program (SDM) aims to meet this need, by educating technically-grounded leaders who will create and manage complex technical systems and products. Through an industry-government-university partnership, the program will draw upon the best of industrial practice and MIT's research and educational expertise to meet industry's and government's needs for engineers with systems perspectives and knowledge. It aims to create and codify new knowledge and practices, devise new modes of educational delivery, and, ultimately, improve industrial competitiveness.

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**SDM Mission**

*To educate future technical leaders (future project managers, future engineering/design leaders) in systems engineering/architecture and the conception and design of complex products and systems, preparing them for careers as the technically-grounded senior managers of their enterprises.*

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In its current design, the SDM program is directly applicable to students in industries that produce, in large volume, complex electro-mechanical, information intensive systems, such as automotive, aerospace, telecommunications and computers. Based upon industrial and government interests, the program will consider expanding to highly specialized low volume products (power plants, ships, building systems) and to process intensive industries (food, chemical, pharmaceutical). The degree program consists of 153 units plus a thesis of 24 units (see **Program Content** section, Page 10). It leads to the degree Master of Science in Engineering and Management.

The SDM program is of direct relevance to companies that manufacture products and develop systems. To the extent that the government is a procurer of these systems and/or acts as a systems integrator, the government also requires leaders with the new knowledge and skills that the program will be developing. Therefore, the program also invites participants from such government agencies.

To develop its intellectual core, the SDM program will collaborate with several Institute research programs in system and product development, including:

- the Leaders for Manufacturing Research Program,
- the Lean Aircraft Initiative,
- the International Motor Vehicle Program,
- the Space Engineering Research Center,
- the Laboratory for Computer Science,
- the Operations Research Center, and
- the proposed new MIT Center for Competitive Product Development.

### Origins and Process

The origins of the SDM program can be traced to the Long Range Planning Exercise of the School of Engineering in 1989. A stated mission of the School was that it

"...aspires to leadership in broadly based engineering education including synthesis as well as analysis, a broad disciplinary coverage and understanding of more than one technology alone, so that its graduates are prepared to deal with complexity and ambiguity, which are the reality of engineering practice."

The commitment to educate professional engineering leaders was explicit:

"...the school is no longer content to educate engineers to be silent implementors of policy set by others...."

One of the specific outcomes of the 1989 plan was the creation of a Committee on Large Systems, which conducted a seminar series and facilitated interdepartmental exchange.

In the early 90's, this group, as well as planning groups in engineering departments such as Aero/Astro,

*(Continued on next page)*

### System Design and Management Program
*Crawley and Magnanti,*
*from preceding page*

proposed an advanced degree in Systems Engineering and Product Development. Of the three panels that conducted discussions leading up to the 1994 Long Range Plan of the School of Engineering, one focused on Second Professional Degrees. Such degrees would provide early–mid career advancement for the emerging leaders of engineering. A

equal to the Leaders for Manufacturing Program. There is a real need for this program and MIT is uniquely qualified to deliver a quality program in this area."

Throughout the fall of 1993 and spring of 1994, a Committee of Sloan and Engineering faculty, led by Joel Moses and John Little, met with industrial representatives and deliberated on the

education (as described below). Representatives and leaders of Sloan, Aero/Astro, EECS, ME, CGSP, and FPC have all been active in this deliberation. This past year, the FPC and CGSP have had considerable input on the program's design, leading to a proposal to the faculty as a whole that was approved at the December faculty meeting.

## Table I
## Subject Summary

| Process Elements | Defining Objectives and Requirements | System Architecture | System Management | System Engineering | Manufacture and Operations |
|---|---|---|---|---|---|
| **Core Subjects** | Product Development | System Architecture | Organizational Processes | System Engineering | Manufacturing Systems |
| **Fundamental Subjects** | Marketing, Strategy | Design Elective, Emerging Technology | Technical Teams, Management Elective | System Optimization, Risk-Benefit, Engineering Electives (2) | |

major finding of the 1994 Long Range Plan was that the School of Engineering should create a Second Professional Degree in complex systems.

Simultaneously, the Sloan School concluded in its 1994 Long Range Plan that a strengthened interaction with engineering was desirable, particularly in the area of design leadership, which would complement the LFM program which aims to educate the leaders of the manufacturing process. The Sloan School concluded in the 1994 Long Range Plan that this effort

"...could be an initiative on a scale

content, form, and organization of the program. This effort led to the first draft program proposal in August 1994.

Since that time, a team led by Joel Moses, Tom Allen, Tom Magnanti, and Ed Crawley (the latter two as program co-directors) has further refined the program plan. Two major meetings at MIT and dozens of presentations at company sites provided corporate input on the program's content and format. A core faculty group has been meeting to solidify the academic offering, and a distance learning team formed to develop the facilities and approaches to distance

One outcome of this process was the creation this academic year of a pilot program with 11 students. The students average four years of industrial experience. They will complete a nine subject, scaled-down version of the program, write a thesis, and receive an unspecified Master of Science Degree by August 1996. The students in the pilot program spent the fall semester on campus and seven of them will complete the program by taking four courses this spring and summer via distance learning.

## System Design and Management Program

*Crawley and Magnanti,
from preceding page*

### Student Audience

Candidates for admission should have three or more years of industrial or government engineering experience and hold a Master's degree in engineering or comparable educational and work experience (including a bachelor's degree in engineering). Preferably, they would have contributed to a product or system development effort, and had at least some limited responsibility as a group or team leader.

Within this broad market, the program has identified at least three target audiences. The first two are traditional ones for MIT: those who will return to MIT for a graduate degree, and those who will be research assistants in programs centered on systems and products. The third market is for students who are full-time employees in industry and government. Some of these students will return to MIT for a fully on-campus format. Due to job constraints, the majority of company and government funded students will be inclined to spend no more than about one semester on campus. The program will provide them with a hybrid on-campus/distance learning experience, as described below.

### Program Content

The program's intellectual content centers on complexity: modeling it, analyzing it, designing with it, and managing it. Students will acquire advanced engineering and management skills needed by practitioners to develop products and design and manage large complex systems. They will learn about the system development process – requirements, concepts, design, manufacturing, validation, and operations – as well as acquire requisite skills in teamwork and leadership.

The curriculum focuses on the overarching process elements of systems design and management, as well as underlying fundamentals (Table I). The process elements encompass requirements definition, system architecture, system management, system engineering and optimization, and design for manufacturability and operability. The foundations include analytic tools, engineering methods, core management skills, and information systems. The curriculum is designed to build upon Master's level engineering education or equivalent student experience.

In part, the program will educate students by examining specific experiences in system design and management within a variety of industries. Company and government partners will share their approaches and experiences through seminars, lessons learned data bases, and a series of "living" case studies. These cases will be based on current and recent past experience of the participating companies and faculty, and the study of industrial practice by participating research students.

Each SDM student will conduct a project and write a Master's thesis. The choice of projects and theses topics will permit great flexibility, with students encouraged to draw upon their own experiences. Theses might examine case studies, design projects, or industrial performance. Students may work on their projects as part of a team, but will write an individually authored thesis. Students who are self-funded will be encouraged to examine or document topics based, in part, on projects that they have conducted in industry. Those funded as research assistants will write a research thesis based in their laboratory or center. Students in industry will be jointly supervised by a mentor at the work site and an MIT faculty member.

### Program Formats

To meet the needs of mid-career students, the program will offer two main degree formats:

- A traditional, though compressed, on-campus format, in which students spend 13 months on campus

- An on-campus/off-campus hybrid

*(Continued on next page)*

> **The SDM program is among the first to participate in the Institute's new distance education initiatives: the goal, to the greatest extent possible, is to replicate participation in a university environment for a student at a work site. Students at work sites will use real time video for class and group instruction, and desktop video and teleconferencing for informal interaction such as "office hours." Access to reference material will be via the World Wide Web (WWW).**

### System Design and Management Program
*Crawley and Magnanti,*
*from preceding page*

## Table II
## Program Options

| | Year 1 | | | | | Year 2 | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | January | Spring | Summer | Fall | January | Spring | Summer | Fall |
| **On-Campus Option** | Courses Taken on Campus | | | | | | | |
| **On/Off-Campus Option** | On-Campus | Courses Taken at a Distance(Part Time) | | | | | | On-Campus |

option, in which students spend part-time on campus, but much of the time at their work site.

The on-campus format, conducted over 13 months, begins and ends in January, and includes two January IAP periods (Table II). The educational experience in this month-long period will include a brief orientation and an intensive grounding in the program. All SDM students, regardless of format option, participate in this intensive month long offering.

The spring, summer, and fall semesters contain normal MIT subject loads, with time reserved for theses in each of the summer, fall, and the second IAP periods.

The hybrid version of the program, which is available to students at participating companies, combines on-campus instruction and distance learning. As shown by Table II, students enrolled in this program option spend the first intensive IAP period on campus, developing a cohort with their fellow students, meeting faculty, being oriented,

and taking the first two subjects. They then return to their job site where over the next 19 months (six semesters) they enroll in two subjects (on average), and work on their thesis in cooperation with a company mentor and faculty advisor. During the distance learning phase, they return once per semester to campus for an intense week of interaction and class work. The students then return for their final full fall semester in residence on campus.

The SDM program is among the first to participate in the Institute's new distance education initiatives: the goal, to the greatest extent possible, is to replicate participation in a university environment for a student at a work site. Students at work sites will use real time video for class and group instruction, and desktop video and teleconferencing for informal interaction such as "office hours." Access to reference material will be via the World Wide Web (WWW).

### Faculty Participation

The SDM program is one of outreach and inclusiveness, and we invite our colleagues from *all* Schools of the Institute to help contribute to the kind of broad education of future technical leaders that SDM aspires to deliver. Opportunities for faculty participation include:

• participation in the program proseminar,

• enrollment of RA's from faculty research programs in the SDM program and in SDM courses,

• participation in the teaching and development of one of the SDM core or required SDM subjects, and

• offering your subject among the electives or recommended subjects.

The SDM program is a noble educational experiment. We need to draw upon the best resources of the Institute. If you are interested, please contact us!✠

# ROTC Task Force: An Update

**Stephen C. Graves**

This past fall, President Vest convened a Task Force responsible for carrying out the final component of the 1990 MIT faculty resolution with regard to ROTC and to the military policy governing homosexual conduct in the armed forces. As chair of this Task Force, I want to use this article to update you on the workings and plans of the Task Force, and encourage you to learn about the issues at hand and become involved in the upcoming debate.

In the late 1970s, MIT adopted its current policy on sexual orientation, explicitly prohibiting discrimination. MIT's policy was in direct conflict with DOD regulations that applied to ROTC and that barred gays and lesbians from military service based on their sexual orientation. Through the 1980s MIT reluctantly regarded ROTC as an exception to its non-discrimination policy. The Vandiver report (Report to the Dean of Undergraduate Education on the MIT-ROTC Relationship, October 1989) discusses this conflict and the basis for the exception; this report also provides the history of ROTC at MIT through 1989.

In November 1989, however, when an MIT student in Naval ROTC was disenrolled on the basis of his homosexuality, this exception became very public and the faculty took on the issue. The resulting debate led to the faculty resolution (October 17, 1990) that is the genesis for the current Task Force. Specifically, the 1990 faculty resolution indicates:

"...that a task force be established by the President near the end of the five-year period to evaluate progress and to recommend a future course of action, with the expectation that inadequate progress toward eliminating the DOD policy on sexual orientation will result in:

i) making ROTC unavailable to students beginning with the class entering in 1998;

ii) giving notice of the impending termination in all appropriate MIT publications no later than the fall of 1996, should it be decided that ROTC is to be unavailable at MIT."

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> We hope to complete by the end of this month an interim report, as the output of the first phase gathering information. This report will present our understanding of the current DOD policy, the so-called "don't ask, don't tell" policy enacted by the Clinton administration, and how this policy is being implemented. ...we also describe what's going on elsewhere. We summarize recent actions on ROTC taken by other schools, including Harvard, Princeton, University of Pennsylvania, and Dartmouth.

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President Vest's charge to the Task Force states:

*The role of the Task Force is to enable the faculty to establish an informed position regarding the future of MIT's relationship with ROTC and the access of MIT students to its programs. The charge to the Task Force is to assemble relevant information on the issue at hand in order to evaluate progress since 1990, to summarize and disseminate this information to the MIT community, to engage the community in an informed discussion of the issues, to frame these issues for the faculty, and to recommend a course of action.*

The membership of the Task Force is myself, Ken Manning, Kim Vandiver, Lisa Steiner, and Will Watson from the faculty; Frank Tipton, a Ph.D. student in Political Science; Alan Pierson, a senior in music and Physics; and Sarah Gallop from the President's Office as staff to the committee. We have a Homepage (http://web.mit.edu/committees/rotc/), as well as an e-mail address for comments (rotc-comment@mit.edu).

To accomplish the charge, we have divided our work into three phases to be finished by March, 1996. The three phases are gathering of information, gathering of community input, and presenting a final report. We are roughly completing the first phase now, namely gathering information, and will be gathering community input over the next month. We then plan to prepare a final report by mid-March to present to the faculty.

We hope to complete by the end of this month an interim report, as the output of the first phase gathering information. This report will present our understanding of the current DOD policy, the so-called "don't ask, don't tell" policy enacted by the Clinton administration, and how this policy is being implemented.

Briefly, the current policy permits gays to enter and stay in the military as long as they do not reveal their sexual orientation or engage in "homosexual conduct." Inductees to ROTC or other branches of the military are not asked about their sexual orientation. However,

### ROTC Task Force:
### An Update
*Graves, from preceding page*

if service members do reveal their status, or if the military receives "credible" evidence that someone is engaging in "homosexual conduct," then an investigation will begin and the cadet or service member may be discharged. A homosexual cadet or service member who reveals his or her sexual orientation may avoid discharge if he or she can successfully rebut the presumption of homosexual conduct.

In this interim report we also describe what's going on elsewhere. We summarize recent actions on ROTC taken by other schools, including Harvard, Princeton, University of Pennsylvania, and Dartmouth. Each has grappled with similar issues concerning the status of ROTC and its availability to their students, and the possible conflict with their non-discrimination policies. We believe that there is great value in understanding what these other universities have done; however, we also recognize that there are differences across these universities and that their "solutions" may or may not apply well to MIT.

There are several court cases that challenge the constitutionality of the "don't ask, don't tell" policy. We are monitoring the status of these cases, and in the interim report we provide the current projections of how and when they might be resolved.

The interim report includes relevant information on ROTC at MIT, and on the benefits of ROTC to MIT and to the student body. We intend for the report to provide sufficient background on ROTC and on the conflict with MIT's non-discrimination policy, so as to be the basis for an informed debate on what MIT should do.

A critical component of the interim report is to sketch a spectrum of possible actions that MIT might consider. For each of these possible actions, the Task Force will outline in the interim report the supporting argument for the action, as well as the counter argument, without making a judgment. Our intent is to lay out a range of options and their cases in a way that allows us to foster a debate within the MIT community and gather community feedback and input.

> So far the Task Force has identified five possible actions for the sake of community discussion and debate. Without going into detail, these actions can be roughly described as (i) maintain the status quo, (ii) sever all ties to ROTC, (iii) postpone action for some period of time or until the courts have ruled on the current DOD policy, (iv) create an arms-length relationship with ROTC so that it falls beyond the scope of MIT's non-discrimination policy, and (v) bar ROTC from campus but create cross-town arrangements for our students to participate in other ROTC programs.

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We plan for wide distribution of the interim report and will publish it on our home page (http://web.mit.edu/ committees/rotc/). Through February, we plan on holding community meetings and targeted forums for the Task Force to gather community input, reaction and advice. The first of these will be the night of February 8 at 7 p.m. in 10-250. Our hope is that these events will provide an opportunity to engage faculty, students, and staff in an informed discussion of the issues, and for the Task Force to get a sense of the MIT community's views on the ROTC debate. This input will be essential as the Task Force works towards a final report and a recommendation to bring to the faculty in March.

So that's where we are and what our plans are over the next couple of months. Please be on the lookout for the interim report and for opportunities to participate in the discussion. We welcome all inputs, and especially any good advice.✣

# TEACH TALK

# Responding Effectively To Student Questions

**Lori Breslow**

This is the second of a two-part "Teach Talk" devoted to the craft of asking and answering questions in the classroom. Last issue's "Teach Talk" provided tips on how to frame cogent questions; this column will look at how to respond effectively to the questions students raise. (In keeping with the spirit of the subject, this "Teach Talk," as the last one, is organized in a question-and-answer format.)   More information on asking and answering questions can be found in *The Torch or the Firehose. A Guide to Section Teaching*, by Arthur P. Mattuck.

\*     \*     \*

#### After I ask a question, how long should I wait for a response?

Hold out as long as possible.  Many instructors, if they don't get a response right away,  immediately rephrase the question, repeat it, or even answer it themselves. (The latter is a particularly bad strategy since students will be even less inclined to make the effort to answer a question if they know the instructor will do it for them if they only wait him or her out.)

Let at least five seconds go by before you say anything.  A study of college physics classrooms found that increasing wait time to five seconds had a positive effect on class participation, not only during that particular class session, but for the course as a whole.  Be patient.

#### What should I do if a student gives a vague – or even incorrect – response to a question I've asked?

Try to find something that's right about the answer. If the response is completely off base, praise the student for at least trying.   However, it's important to identify wrong answers, so that other students don't become confused or misinformed.

#### What can I do to get my students to ask questions?

Professor Arthur Mattuck, who regularly watches videotapes of new instructors in the Mathematics Department, reports that "miles of videotape" show "instructors finishing an explanation, asking (or mumbling) 'Any questions?' and almost in the same breath continuing, 'Well, if there are no questions, let's go on with . . .'"

Give students a chance to frame their questions. The silence that follows your earnest, "What questions do you have?" may be uncomfortable, but it's important. Convince students with your tone of voice and body language that you are receptive to their inquiries. (Do this from the very first class.) Don't browbeat students for not asking questions, and be enthusiastic when they do.

#### How can I best manage the process of answering students' questions?

There are several common-sense techniques to keep in mind to make sure you are answering students' questions effectively:

• *Be sure you understand the question that's being asked and that everyone else in the class has heard it.*  Both of these things can be easily handled by repeating the question.  If you're not sure what the student asked, rephrase the question in your own words, and check in with the student to make sure that's what he or she wants to know.  If the question was asked in hushed tones by the student sitting in the front row, ask him or her to turn around to the rest of the class and share the question with them. (This has the added benefit of giving students the opportunity to practice speaking in front of a small group.)

• *Be as direct as possible as often as possible.*  Ronald Hyman, an expert on the strategic use of questions in the classroom, makes the point that most students don't ask questions to get attention or to be disruptive; they ask them because they're confused or curious about something. Therefore, it's usually not a good idea to deflect the question, either by asking another student to comment on it or by asking the student a question in return .  If you do want to use either of those tactics for some strategic purpose, signal to the student that's what you're doing.  For example, you could say, "That's a good question, which has a range of possible answers. Let's see if we can get some of those answers out on the table first; then I'll give you what I think are the best ways to approach this problem."

## Teach Talk

### Responding Effectively
### To Student Questions
*Breslow, from preceding page*

• *Ask the student to wait for an answer to his or her question if that answer is going to lead the class away from the topic currently under discussion.* If the question is truly out of sync with the material you are covering, ask the student if you can come back to it at a more appropriate time. Try to give the student a general sense of when he or she can expect an answer.

**What happens if a student asks a question that is so elementary that everyone else in the class already knows the answer to it?**

First, try to determine if, in fact, the question is one to which most other members of the class know the answer – instructors often overestimate the knowledge and competency of their students. In any case, it's better to review material some students already know than leave many of them confused and frustrated.

If you are convinced that class time would not be utilized well by responding to the question, tell the student that because of time constraints, you would prefer to answer the question for him or her after class. Again, this is a face saving maneuver for the student. As Phillip Wankat writes in his book, *Teaching Engineering*, asking a question can often be "an act of bravery" for the student so be sympathetic. The way in which you react to one student sends a message to others about how welcome questions are in your classroom.✢

\* \* \*

> **The Department of Mechanical Engineering is sponsoring a seminar entitled "Improving Lectures" by Phillip C. Wankat, Professor of Chemical Engineering at Purdue University and author of** *Teaching Engineering***. The seminar will be on February 9th from 3:00-4:00 in 3-270.**

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## *Letters*

To The Faculty Newsletter:

**MIT Contacts with China?**

Three contributions in the October '95 *Faculty Newsletter* dealt with MIT contacts with China. I think that a thorough reconsideration of contacts between MIT as an institution and the official China is necessary before we go any further. China is a serious abuser of human rights both internally and as an occupier of Tibet. Any serious study reveals facts which are actually much worse than what newspaper articles or 30 second TV spots reveal. For instance, China uses systematic destruction of the environment in Tibet to destroy this society which was exemplary in keeping a balance between humans and nature.

Contacts of individuals at MIT with Chinese individuals cannot be interpreted as tolerating or supporting human rights abuse; as a matter of fact, they may help Chinese individuals and at least make communication of a full range of values possible. The situation is different when dealing with the official China. While each individual at MIT has to apply his or her moral standards when establishing such contact, a different set of standards needs to be applied when doing this as an institution. I consider this as a very serious issue and before we go any further with joint programs and conferences we should sit down and think about what should be done.

**Herbert H. Einstein**
**Professor of Civil and**
**Environmental Engineering**

To The Faculty Newsletter:

I am one of the Faculty Newsletter's "paying" subscribers. I started my subscription about a year and a half ago because there were some very interesting articles about the faculty's view of reengineering. I kept hearing about articles in the *Newsletter* from my work colleagues, and finally decided to subscribe so I, too, could know what they were talking about. I also found the articles about students interesting, because I used to work in a student service office and was a freshman advisor before I came to Information Systems this past summer.

I was happy to see that once again an issue has arrived. I have read that the *Faculty Newsletter* may eventually go on-line and I encourage you to make that happen. That is how I read *The Tech*.

**Shirley Picardi**
**Director, I/T Competency Groups**
**Information Systems**

## Preliminary Results from the Faculty Survey

*Hansman, from Page 1*

attitudes towards retirement opinions. The third element asked the respondent to rank the importance of the specific factors shown in Table 1 to their retirement decision on a 5-point scale in which 1="Not a Consideration," 3="Somewhat Important," and 5="Essential." In addition a free response option was included in each factor area.

The fourth survey element queried opinion on resources required for institutional support of retired faculty and how funds released by faculty retirements should be used. The last element of the survey addressed perceptions on the need for pre- and post-retirement counseling.

### Distribution and Respondent Demographics

The survey was distributed using campus mail to all listed full-time faculty members in the ranks of Assistant, Associate and Full Professor (N = 1100). In addition, the survey was distributed to all Emeritus faculty members for whom accurate address data were available (N = 245).

A total of 324 surveys were completed and returned including 265 full-time faculty and 59 Emeritus faculty. For the full-time faculty the response rates were similar for each of the schools. Because of the larger size of the Schools of Science and Engineering, these schools dominate the combined results. The mean age of the full time respondents was 52.2. The response rate for the Tenured Full Professors was higher than for the Associate or Assistant ranks

indicating a higher degree of interest in retirement issues among the more senior faculty.

### *Results*

#### Ideal Retirement Age

The age at which individuals indicated they would *ideally* like to retire is shown in Fig. 1 and is plotted against the current age. In addition to the plotted data, 7 faculty responded "never," and 23 faculty indicated that they did not know what their ideal retirement age was. Note that only the full-time faculty are included in this analysis plot. The data indicate

that a significant number of faculty will be interested in continuing past a retirement age of 70. It is also interesting to note that there is a trend to push back the ideal retirement age with increasing current age.

#### Interest in the Retirement Arrangements

There was strong interest in part-time retirement arrangements, as can be seen in Fig. 2. Over 90% of the respondents indicated at least "some interest" and 43% of the faculty found such arrangements "highly desirable." The preferred types of part time arrangements are shown in Fig. 3.

Table 1.

| Teaching Access | Institutional Access |
|---|---|
| Undergraduate students | Library |
|   Courses | Internet |
|   UROP | Telephone Services (e.g. Forwarding) |
|   Other_____ .. ____ | Mail Services (e.g. Forwarding) |
| Graduate Students | Athletic Facilities |
|   Courses | Parking |
|   Research Supervision | MIT Discounts (e.g. Computers, Travel) |
|   Other_____ --- | Other_____ |
| **Research Access** | **Space** |
| PI Eligibility | Office |
| Advising Graduate Students | Lab |
| Other_____ . .. ____ | Quality (e.g. Private Office) |
| **Status** | Other _____ |
| Title (e.g. Maintain Title of Professor) | **Staff Support** |
| Faculty Voting Privileges | Secretary |
| Perception of Outside (MIT) World | Technical |
| Eligibility for Inst. Committees | Administrative |
| Other _____ | Other_____ |
| **Collegiality** | **Scholarly Allowance** |
| Dept. Faculty Meetings | Travel |
| Inst. Faculty Meetings | Books |
| Mail Lists (e.g. Seminar Announcements) | Equipment |
| Other_____ . _____ | Computers |
| **Medical** | Student Support |
| Current Health Plan Eligibility | Other____ _____ |
|   Self | |
|   Dependents | |
| Access to Your Current Medical Facilities | |
| Medicare/Medigap Administrative Support | |
| Availability of Supplemental | |
|   Comprehensive Insurance | |
|    in Managed Care Setting | |
|   - in MIT Health Plan | |
| Other_____ . _____ | |

### *Perceived Importance
of Specific Factors*

#### Medical Issues

Access to medical care was clearly rated as the most important specific factor by those surveyed. In Fig. 4, 81% of the respondents rate *Current Health Plan Eligibility* for themselves as "essential" (n.b. 75% of the respondents are members of the MIT Health Plan).

In reviewing the MIT benefit plan, the committee confirmed that full coverage and access to medical benefits *are* available to faculty after retirement without regard to part-time employment. The committee did find some confusion on this issue because prior to retirement, part-time positions less than 50% do not receive medical benefits. Me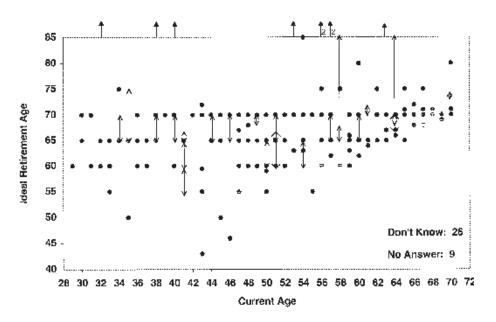dicare, which is available after age 65, also complicates the medical benefits picture, but should not reduce medical coverage for retirement.
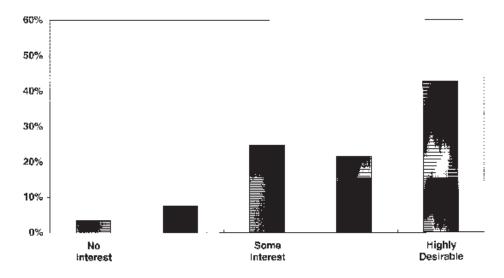


**Figure 1. Ideal Retirement Age.**

#### Issues of Status

The responses to several questions relating to status after retirement are shown in Fig. 5. The most important factors in this area were *Title (e.g. Maintain Title of Professor)* and *Perception of the Outside (MIT) World*. It is clear from the data and the comments that Title is a significant factor which impedes the decision to retire or redefine terms of employment. In some cases this is due to external funding considerations resulting from the perception that some funding sources are reluctant to commit funds to Emeritus faculty. In other cases it is simply the desire to maintain the status quo. There is also the perception that the existing titles for part-time retired faculty (Emeritus or Senior Lecturer) do not adequately reflect the desired commitment, status, and activity of these positions.

**Figure 2. Level of Interest in Part-Time Teaching or Research Position.**

**Preliminary Results from
the Faculty Survey**
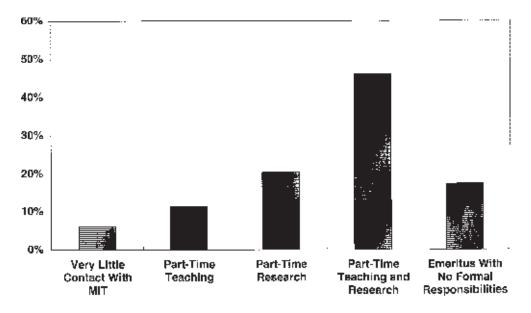
*Hansman, from preceding page*

**Figure 3.  Type of Arrangement Envisioned.**

**Figure 4.  Current Health Plan Eligibility.**

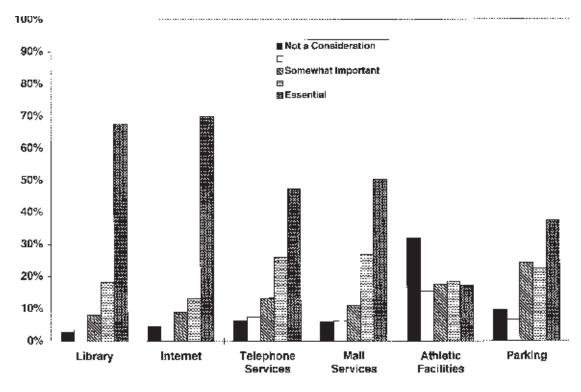Figure 5.  Status Issues.



Figure 6.  Institutional Access.

**Preliminary Results from
the Faculty Survey**
*Hansman, from preceding page*

### Issues of Institutional Access

A number of institutional access factors were assessed and are presented in Fig. 6. With the exception of *Access to Athletic Facilities,* these factors were generally considered important. The most important were *Access to Library* and *Internet.* These were followed by *Telephone* and *Mail* Forwarding Services. *Parking* was also considered important, but less essential. It should be noted that proportionately more current Emeritus faculty felt that parking was essential than current full-time faculty.

### Issues of Space

The perceived importance of Office and Lab Space is shown in Fig. 7. Office Space is clearly an important factor while the importance of Lab Space is variable depending on the interests of the particular faculty member. Because the quality and location of the space is also important, this will be a challenge for the administration in the future as the number of retired faculty members rises due to the natural demographics of the Institute.

### Resources and the Importance of Intellectual Renewal

The results of the questions on resources indicate that the faculty understand the issues and challenges to intellectual renewal. For example, in the data in Fig. 8, the faculty felt that over 59% of all resources freed from retirement should be used to hire Assistant Professors. In addition, over 52% of the survey respondents
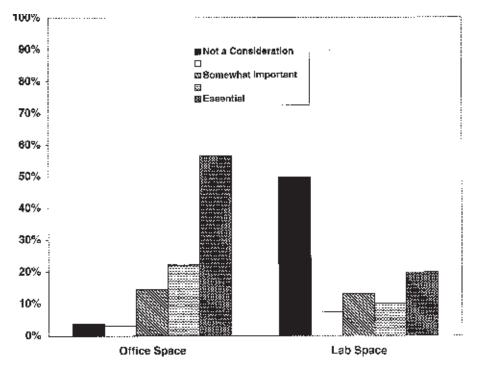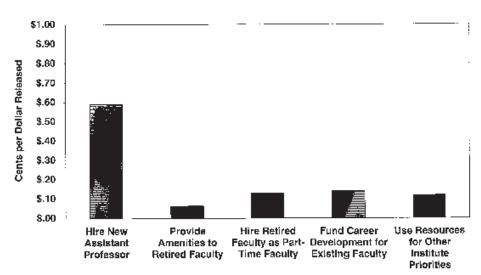


**Figure 7. Space Issues.**



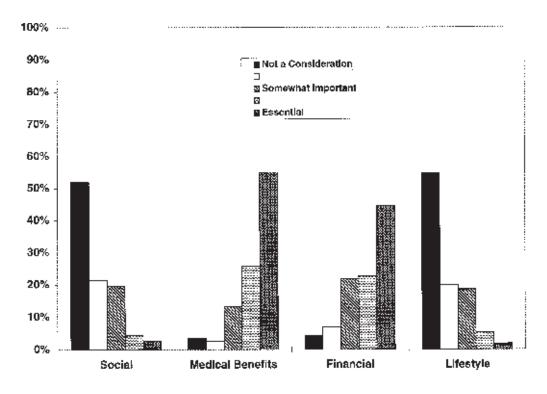**Figure 8. Suggested Use of Funds Released by Faculty Retirement.**

**Figure 9. Pre- and Post-Retirement Counseling Resources.**

were willing to have a reduction of 5 or more faculty across the Institute to fund activities associated with retirement and intellectual renewal.

### Counseling

The results from the questions on pre- and post-retirement counseling are shown in Fig. 9. The faculty indicate that Counseling on Medical Benefits and Financial issues was important but felt that counseling on Lifestyle or Social Issues was unnecessary.

### *Conclusion*

There appears to be a strong interest in developing part time tapering strategies for faculty retirement. The most important factors were medical, institutional access, space, and title. The faculty appear to recognize the importance of intellectual renewal to MIT and the Committee on Faculty Administration will continue to work with both the faculty and the administration in this area. To this end, the Committee would welcome any thoughts or input.✣

# Writing Requirement Changes Planned;
# Greater Communication Experience Needed

### Kip Hodges, Alan Lightman, Leslie Perelman

Today, technical institutions all over the country are faced with a dilemma. At a time of increasing pressure to add more technical content to the curriculum, training in communication skills is becoming more and more essential to professional success. While we as yet have no comprehensive solution to this competition of demands, MIT has an opportunity to help establish a new national standard for science and engineering education in the twenty-first century. To accomplish this goal we need a reconception of the Writing Requirement, moving from tests of minimum proficiency to a sustained experience in writing and speaking, while creating no substantial increase in student and faculty work loads.

At the request of the Committee on the Undergraduate Program, the Committee on the Writing Requirement will soon begin discussions with faculty and students to find ways of effecting a new Requirement consistent with the educational goals of departments and time budgets of students and faculty. We would like here to provide some background for these discussions.

In terms of rigor, MIT's current Writing Requirement is somewhere in the middle of similar requirements at other technically-oriented institutions. For example, WPI has no writing requirement; Caltech has a requirement roughly similar to MIT's Phase I requirement but nothing equivalent to our Phase II; the Rensselaer requirement is very similar to the current MIT requirement, both in Phase I and Phase II; the Georgia Tech requirement is more extensive than MIT's in Phase I but less in Phase II; the Cornell engineering school requirement is more strenuous than the MIT requirement across the board.

### The Importance of Integrated and Sustained Experience

The current Writing Requirement, formulated in 1982, had two stated goals: "first, to ensure that by the end of their first year at the Institute all undergraduates possess a minimum competence in general expository writing [Phase I]; second, to ensure that undergraduates become proficient in the particular forms of writing used within their major discipline by making writing an integral part of every undergraduates's professional education [Phase II]." These goals, in large part, echo the second recommendation of the famous 1949 survey of education at MIT, the Lewis Report: "We recommend that the teaching of the formal techniques of composition . . . be made an integral part of all subjects in the humanities and that the development of the student's ability to communicate orally and in writing be emphasized in the professional subjects as well as in the humanities." In other words, for almost fifty years MIT has recognized the value of integrating oral and written communication into the rest of the educational experience.

We want to re-emphasize the importance of an *integrated and*

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> A significant result of the study by the CUP subcommittee was the lack of any correlation between a student's overall GPA and his or her writing ability. (See Figure 2.) This result reinforces the realization that the present culture at MIT does not encourage attention to communication skills. Students interviewed by the CUP subcommittee commented that "science and engineering subjects de-emphasize writing" and that "students are so focused on science and engineering they don't have time to work on writing and communication."

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*sustained* experience in communication. All recent studies of undergraduate writing, such as the 1994 *Study of Undergraduate Writing at Harvard*, suggest that significant improvement in students' writing can be achieved only by constant writing, with substantial instructor feedback, over the entire undergraduate career. (We can only assume that training in oral communication, which MIT does not presently require at all, follows a similar pattern.) One-shot encounters with writing, such as a single expository writing class or, much less, one or two papers, have little lasting effect.

### The New Job Market

The job market is changing. Good communication skills are even more crucial today than at the time of the Lewis Report, or even than in 1982, when the current Writing Requirement was put into place. Engineering and other technically oriented professions have become increasingly inter-disciplinary and now require considerable skill in communicating results, both orally and in written form, to a wide range of people. In an April 1995 article in the *Journal of*

### Writing Requirement
### Changes Planned
*Hodges et al., from preceding page*

*Engineering Education*, for example, it was estimated that eighty percent of an engineer's work time is now spent in communicating. Boeing Aircraft recently distributed to our Aero/Astro department an official list of "Attributes of an Attractive Engineer Graduate," which included "Good Communication Skills: written, verbal, graphic, and listening." Robert Metcalfe '68 EECS, inventor of Ethernet and founder of 3Com, began a recent lecture to 6.033 students with the comment that "Writing is essential to successful engineering." Metcalfe went on to say that writing is one of the principal ways "to make engineering projects successful and to advance an engineer's ideas." Finally, an increasing fraction of MIT students (now approximately 20 percent) are applying to medical schools, which require applicants to have a more thorough experience with expository writing than now required in our curriculum.

#### A Recent Study of Writing at MIT

Now we come to the actual writing experience and ability of our students. Despite its admirable goals, the Writing Requirement as currently implemented does not provide our students with the communication experience they need for successful careers. We do not have space here to review the current implementation in detail, but suffice it to say that students can satisfy both Phase I and Phase II of the Requirement with very little practice in writing (and no practice in speaking). Many students do so, often graduating with only one or two subjects involving substantial writing. Only 40 percent of members of the Class of 1994 responding to the Senior Survey reported that MIT had "greatly" or "moderately" improved their writing skills, compared to 71 percent of a comparison group of science and
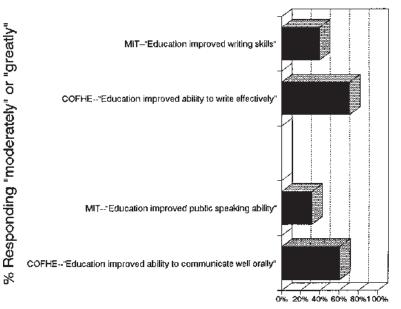
engineering seniors at Harvard, Cornell, Johns Hopkins, and Rice. (See Figure 1.) The disparity between MIT and other schools in speaking skills was even greater.

In the fall of 1994, in response to faculty concerns over the effectiveness of the Writing Requirement, the CUP commissioned a special subcommittee to study both phases of the requirement and students' writing abilities. The subcommittee was co-chaired by Professor Kip Hodges, chair of the Committee on the Writing Requirement, and by Professor Alan Lightman, head of the Program in Writing and Humanistic Studies. Other members of the subcommittee included Professor Fernando Corbato, EECS; Professor Suzanne Flynn, Linguistics and Foreign Languages and Literatures and chair of the Committee on the Curriculum; Professor Steven Kleiman, Mathematics

and departmental writing coordinator; Dr. Leslie Perelman, Associate Dean and coordinator of the Writing Requirement; Professor Ronald Rivest, EECS and member of CUP; Professor Rosalind Williams, now Dean of Undergraduate Education and faculty director of the Writing Initiative; and Terrence Collins, '95 and member of CUP.

Over a six-month period the CUP subcommittee examined the writing and academic profiles of a sample of MIT juniors. The subcommittee also interviewed departmental writing coordinators, HASS-D instructors, other interested faculty, and students. The CUP subcommittee's principal findings, delivered to the full CUP in a report early in the fall of 1995, were:

(1) A small but non-trivial fraction of MIT students (between 15 and 20

**Figure 1**

### Writing Requirement
### Changes Planned
*Hodges et al., from preceding page*

percent) are particularly deficient in writing skills upon entrance. These same students, who are not concentrated in any well-defined subset of the undergraduate population, continue to have difficulty with writing throughout their undergraduate career.

2) A quarter to a third of MIT students have inadequate writing skills at the time of their junior year, despite having already passed Phase I of the Writing Requirement.

communication skills. Students interviewed by the CUP subcommittee commented that "science and engineering subjects de-emphasize writing" and that "students are so focused on science and engineering they don't have time to work on writing and communication." All faculty, including faculty teaching HASS subjects, feel that it is difficult to add writing instruction to the content they are

### A Look to the Future:
### MIT Graduates as Leaders

A revision of the current system, to provide a greater and more sustained experience in communication, will almost certainly retain a menu of choices. A model for one of these choices may be the Writing Initiative, begun on a trial basis in 1993-1994. The Writing Initiative consists of six-unit "practica" attached to regular engineering subjects and designed to improve written and oral communication skills within the context of that subject. In 1994-1995, 17 practica were offered.

The Writing Initiative has been widely praised by faculty, students, and instructors. Any new Writing Requirement will, of course, need to mesh with the complete curriculum; in particular, we cannot expect to increase the total work load of our students. What we can expect is to recognize the increasing priority of communication skills in the educational experience. We have a responsibility to our students. We wouldn't consider graduating a mechanical engineer who couldn't calculate the stresses in a metal; we shouldn't consider graduating the same student who cannot communicate his or her results to a corporate executive or environmental consultant or congressional aide.

If we do not give our students the skills to communicate well, we are not preparing them for tomorrow's job market. In particular, we are not preparing them to be leaders. Engineering firms, corporations, research studies, and our own former students are all telling us the same thing: communication skills have become crucial for professional success. As we approach the year 2000, we have an opportunity not only to prepare our own students for the new professional world, but also to serve as a role model for technical institutions and universities across the country. ✣



## Mean Grade Point Averages of 32 Juniors By Quality of Writing on HASS-D Papers
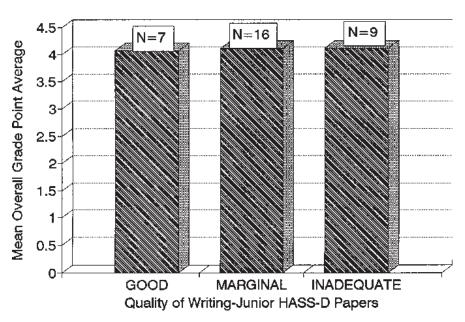
**Figure 2**

(3) The writing skills of many of our students are not much better when they graduate than when they entered as freshmen.

A significant result of the study by the CUP subcommittee was the lack of any correlation between a student's overall GPA and his or her writing ability. (See Figure 2.) This result reinforces the realization that the present culture at MIT does not encourage attention to

primarily being asked to teach. Faculty involved with implementing the current Writing Requirement report frustration with the requirement and doubt whether good writing instruction is possible within the current system. Too many students and faculty perceive the current Writing Requirement as a hurdle, rather than an opportunity for learning essential professional skills.

# Anonymous Angry Communications

### Mary Rowe

Ombudspeople around North America have been reporting an increase in numbers of anonymous attacks against individuals and anonymous angry political statements sent to individuals. There has been a significant number of such events at MIT this fall, including unsigned posters, poison pen letters, focused vandalism, the mailing of obscene objects, apparent attempts physically to injure others, apparent attempts to interfere with the research of others, and the like. Some of these events at MIT in 1995 appeared to be ad hominem and many appeared to be motivated by strong feelings about race, gender, sexual orientation, religion, and nationality.

Most people in the MIT community believe that a university is a place where every point of view should be debatable, especially in the classroom. Many people also think there may occasionally be a place for a communication that responsibly and anonymously reports "facts," about some situation that is unsafe or illegal, especially when people fear reprisal.

My reason for writing about anonymous angry communications is not to raise concerns about the "content" of the anonymous communications, except for those few which contain threats or are by their nature threatening. I want rather to report that the "mode" of anonymous, angry communication is usually very upsetting to the faculty, staff and students who have been targets. Those who are the objects of anonymous angry communications often think about leaving MIT; they lose sleep, report difficulties in concentrating on their work, and often feel they must change their normal routines.

These events are arousing concern where they have come to light. One concerned faculty member said to me that "In these attacks we are all attacked because anonymity undermines openness, fairness and the implicit notion that we all take responsibility for our views – three of the many pillars that uplift us." Another wrote to me: "This type of communication has no place in a collegial, intellectual community." Another professor wrote: "(This is) an unacceptable form of communication for professionals," and another colleague wrote, "anything like this is totally unacceptable in any environment but particularly an academic community, it should be met with outrage by faculty and staff."

In some cases thoughtful faculty and administrators have taken a strong stand about these events: affirming the right of students and others to raise unpopular points of view – and condemning anonymous angry attacks. This stance is in line with MIT procedures which, for example, defend the posting of an unpleasant poster if it is signed, while removing offensive posters that are not signed. There is evidence to suggest that this kind of leadership is sometimes effective in encouraging members of the community to tolerate offensive, complaining, or dissident points of view that take place in responsible discussions – and in discouraging covert methods of attack.

Anyone who wishes to discuss an anonymous angry attack, especially if there is a question about the options available in such a situation, should feel free to call the relevant department head, senior colleague or senior officer, the Campus Police, my office, or other resources. ❖

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# UROP - Very Much Alive

### Norma McGavern

One piece of discouraging news for UROP followed another in 1994, when federal regulations began taking a large slice out of faculty sponsored research funds used to pay UROP students. Costs to faculty rose in July that year by over 60%. Cost sharing of student stipends with UROP's own funds came to an end. This year the outlook seems a little brighter.

The first fall after the new regulations concerning indirect costs went into effect everyone, UROP staff included, expected a dramatic decrease in participation. No surprise there – 38 percent fewer students were able to work for pay. Prospects for the rest of the year looked even dimmer.

Yet in fall 1995, UROP participation increased by 11 percent compared with last fall. Looking at pay alone, the increase is 15 percent. Qualities that make UROP valuable for faculty as well as for students are clearly at work because stipends are as expensive – 65 percent added cost – as they were last year. Granted, a less optimistic view would compare fall 1995 with fall 1993: UROP is 19 percent below that pre-new regulations number, a better than predicted showing nonetheless. Summer 1995 turned out to be lower by about the same amount – 20 percent – from summer 1994. Maybe 20 percent is as bad as it will get.

Other cheering news came from the number of gifts, mostly funds for endowment, that UROP received this past year. In December alone, UROP's endowment moved ahead by about $100,000. Donations from alumni, mostly recent graduates, and many of their gifts of small dollar amounts, added up to $40,000 in a single month. At about $1.8 million, UROP endowment is still embarrassingly small for a 27-year-old program, especially a program so praised, copied, and obviously important to MIT.

We look forward to the growth of our Undergraduate Corporate Research Fellows (UCRF) program created just last year. UCRF offers corporations the means of sponsoring UROP research for a set yearly fee of $9,475. United Technologies has been the largest sponsor to date. This may turn out to be one of the more effective ways UROP can put 20% more stipends in students' pockets. ❖

### Tough Times Ahead: A Graduate Student Perspective

*Souter, from Page 1*

find sufficient funding to continue to pay them until they complete their degrees. But in terms of how students feel about their future careers as researchers, many students feel disillusioned about their prospects. They may have started out with the expectation that they would get a Ph.D. and then go on to a job in academics, but now realize that there are just not enough faculty or research jobs out their for them.

It doesn't take a rocket scientist to figure out that the current production rate of Ph.D. students cannot be continued indefinitely. If I have two students, and they have two students, and so on, and so on... One would hope that any MIT graduate student would recognize this as exponential growth that cannot be supported with flat or linear increases in research funding, especially not with decreases in funding.

Students often have little choice but to go into industry after graduating, or into less traditional fields, at least for scientists and engineers, such as business and finance. Students who make this career jump often feel stigmatized, as if they have let their advisors and peers down. Although their skills are appropriate to the jobs they accept, and are highly valued by the companies that hire them, often students feel that they are wasting their skills by not entering academia.

Clearly this trend must change. Incoming graduate students should be given a realistic view of their future, and their training should be in line with their prospects. Many graduate students favor decreased numbers of Ph.D. students. They would rather see a higher ratio of postdocs to research assistantships. As the cost of an R.A. approaches the cost of a postdoc it makes sense to hire someone who is more experienced and

can produce higher quality research sooner. Besides, why take on new Ph.D. students when the ones you have can't get the jobs they are trained for?

As research funding becomes more scarce, the competition to get into Ph.D. programs should also increase. As Ph.D.

programs shrink, enrollment in professional degree programs, M.Eng. or M.Sc. programs, should expand. Many students and faculty would agree that MIT is not doing any favors to a struggling student by giving him or her a Ph.D. when he or she would often be better off with a Master's degree in today's job market. Increasingly, only the best and luckiest are able to find faculty jobs.

For students who do complete Ph.D. programs, one thing they will need from faculty as more of them go into non-academic careers is to feel that such an alternative path is not a booby prize for mediocre performance, but is a respectable career option. It is critical for students to obtain the approval of their advisor and peers in their career choices. This is the responsibility of faculty, as they are the students' mentors. An advisor sets the standards that his or her students try to live up to. It is unfair to teach students that the only legitimate career path is one in which it is difficult or impossible to find job.

As the uses to which the graduates put their graduate degrees change, so too

must the nature of their education. Students will require, and employers will value, graduate programs which provide breadth. Rather than focusing on one problem in one highly specialized aspect of a science, students will need to be trained to be general problem solvers.

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Rather than graduating from a program knowing everything about one subdiscipline, students should graduate with a tool kit full of problem-solving tools, with which they can attempt to understand new problems in brand new fields.

Many students are already beginning to recognize that a Ph.D. in science or engineering is the modern equivalent of the liberal arts degree. It does not lock you into a career in research any more than a history major twenty years ago locked you into a life of teaching high school history. These degrees are a stepping stone to new careers. They teach you how to think and how to learn in today's world. The challenge MIT faces now is to recognize this shift in the paradigm of graduate education; to prepare for it by introducing new graduate programs and by changing current curricula; and to exploit it. MIT's future in providing a superior graduate education lies in giving graduate students the breadth and expectations that will prepare them to compete in a nonacademic job market and to contribute to an ever changing world.✤

# Undergraduate Perception of Reengineering:
# Lack of Awareness and Skepticism

**Carrie Muh**
*Special to the Faculty Newsletter*

In my role as President of the Undergraduate Association, I have had the opportunity to talk to many undergraduates to gather feedback and opinions on the current reengineering process. Over the past few months, it has become obvious to me that there is a dichotomy in the perception of this process held by MIT's undergraduates.

Those undergraduates who generally approve of the reengineering process tend to be the students who have been brought into it directly, such as those who serve on Institute committees or who have spoken personally with faculty, administrators and reengineering committee members about the process. For the most part, these students approve of the direction reengineering is taking; they like the fact that a serious attempt is being made at getting student input and understanding the points of view of all members of the MIT community.

However, among the students who have not been personally involved in meetings or forums or any aspect of the process to date, the feelings are quite different. These undergraduates are either completely unaware that reengineering is happening on campus, or are aware of its existence but are hesitant to support it. Often when I have asked other undergraduates how they feel about reengineering, they tell me that they believe this is just another series of committees who will hold meetings, issue reports, and be forgotten; having accomplished nothing of visible value to the students on campus, or to basically anyone other than a few administrators. Even though there have been articles written about reengineering in various campus publications, most students do not take the time to read and understand the implications of this process.

As we all know, MIT is a very busy place, and most of its undergraduates came here for the excellent educational opportunities it will provide to us. Generally we do not pay much attention to student services or administrative functions until there is a problem. This means that there will always be quite a few students who simply do not care to get involved in anything that does not directly affect their education. Those of us who are concerned, however, are most anxious about the effect that reengineering could have on how student services are managed on campus, and are optimistic that significant improvement can be achieved. Student services range from how student activities and clubs get room space and posters in order to hold events on campus; to the process by which students register and pay to take classes; to the way we determine what dorm we live in and if we want to take our meals in campus dining halls. Essentially it includes everything that students directly deal with on campus outside of the actual information we study.

Many undergraduates are dismayed by the fact that most of the offices on this campus appear to run with virtually no communication among themselves or with students. Nearly every student I've talked to has had some story to tell of how it took them more than a year to get credit for classes taken at another school even though all the paperwork was filled out correctly at the very start of the process; or about how the Registrar's Office refused to allow them to register for classes because it appeared they still owed MIT money — even though the Bursar's Office told them that they did not owe anything else, or the Financial Aid Office told them that all of their financial aid had come through as expected. The number one complaint that I have heard from undergraduates about MIT (other than working too hard, but that usually seems more like bragging than complaining) is that offices and departments each act independently of each other and even when their work overlaps, it appears that they do not share information or cooperate with one another. Many undergraduates feel that this lack of communication will prevent any real changes from taking place.

In order to develop more student support overall, and eliminate the existing dichotomy, I would like to recommend that there be a widely published and very visible summary of all of the basic changes being contemplated on campus, and how those changes will affect students. The dilemma is how to create something that people will read and pay attention to despite their busy schedules. I hope that some creative solutions can be devised for how to disseminate this information, so that students will know that this process will try to eliminate problems that nearly all of us have faced, by more closely unifying offices which affect students or by streamlining processes which each of us must go through many times while enrolled here. I believe that if students are more aware of precisely what concrete changes are being contemplated, and how these changes are expected to benefit the average student, they will be much more willing to become directly involved and to give their suggestions or at least support of the process.

Students should be convinced that reengineering will not just be another series of forgotten committees or another attempt at cutting costs for the school while not improving services for students, staff, or faculty in the slightest. We want to be sure that this time the entire MIT community is being considered and that the Institute truly wants, and expects, all of us to benefit directly from the changes.✣

### Mail Services
### Redesign Explained
*Lambert, from Page 1*

For example, if evaluated by itself, the new distribution model appears to simply shift the burden of mail delivery from the central services to departmental labor. However, there were compelling and beneficial reasons for the implementation of the new distribution model. MIT plans to negotiate improved US Postal Service (USPS) delivery. One USPS requirement for making this change is the existence of centralized mail room locations. It also was necessary to create locations to exchange outbound USPS mail. As the processing of outbound mail shifts to the new centralized processing model, associated work will shift from departmental labor to the central services.

It is not uncommon for work loads to shift as a result of process redesign. Shifting work loads is not an inherently negative result of process redesign; however, it does need to be recognized, understood, and to be justifiable.

Two teams have reviewed mail processing at MIT. Several problem areas were identified, including the following:

• MIT was not positioned or organized to deal with advances in mail-related technologies, USPS rate changes, or changing customer requirements. No central expertise or responsibility existed for mail processing.

• MIT was not taking advantage of postal discounts. The USPS has introduced a number of discounts to encourage the use of "automatable" mail. Unnecessary and excessive postage was common. There were no economies of scale due to lack of centralization.

• The volume of "unwanted" mail was staggering. Unwanted mail takes the form of duplicated mailings, "junk" mail, and mail for employees who no longer work at the Institute. Unwanted mail is both internally and externally generated. Roughly half of the estimated 17 million pieces delivered annually is considered junk mail by the recipients.

> **An unequitable delivery service existed. There was a popular belief that the entire campus received "desktop delivery" service from the central services. An extensive review of the prior delivery service indicated that only 10 percent of the entire campus received desktop delivery. In some cases, an entire building received a single unsorted bag of mail for its occupants.**

• There was no driving force to reduce paper mail. The estimated annual total volume of mail at MIT is 24 million pieces of incoming, outgoing, and internal mail. Technology changes allow for more cost-effective and efficient methods for distributing information.

• There were large dollar investments in departmental mailing equipment and related labor. Most of this equipment was grossly underutilized. There were more than 140 postage meters on campus. Departmental mail expertise was minimal at best.

• An unequitable delivery service existed. There was a popular belief that the entire campus received "desktop delivery" service from the central

services. An extensive review of the prior delivery service indicated that only 10 percent of the entire campus received desktop delivery. In some cases, an entire building received a single unsorted bag of mail for its occupants.

• MIT was receiving less service from the local USPS office and from other carriers than could be negotiated.

• Poor and inconsistent MIT addresses are pervasive. The lack of a consistent and valid address format has a dramatic negative impact on mail sorting and delivery times for both the USPS and MIT's mail workers.

• Internal maintenance of MIT mailing lists is uncoordinated and very frustrating to the community.

The redesign of the mail processes began with the hiring of a professional mail manager and the creation of a centralized group. The new Mail Services team is now responsible for all mail processing at MIT. Mail processing plus postage is a $6 million cost to MIT. In addition to handling the day-to-day mail operations, this new team is focusing on the following areas:

## Mail Services
## Redesign Explained

*Lambert, from preceding page*

• Approximately 35 Distributed Mail Centers (DMCs) will be created. The new distribution model will provide the necessary exchange locations for incoming and outgoing mail between departments and the central services. DMC locations are negotiated with the departments in most cases. Convenience was one of many criteria used for determining the location of each DMC. For example, the Building 3 DMC is located adjacent to the heavily used Graphic Arts Copy Center in Building 11. Customers have 24-hour access to the DMCs, addressing one of the community's requests. The new model will allow for two daily pickups and deliveries when the entire campus is converted to the new system. Additionally, mail will be delivered earlier in the new system.

• We currently produce 7 million pieces of outbound mail annually. MIT will centralize the processing of all outgoing USPS mail. Departments will save on both labor and mailing equipment costs. The Institute as a whole will realize significant postage savings associated with volume discounts via presorting, barcoding, and mail consolidation.

• A major effort and campaign to reduce unwanted mail will be introduced. Customers will determine which mail they do not wish to receive. Mail Services will drive this effort and process requests efficiently from their central operation. In addition to dealing with individual requests, Mail Services will review and modify vendor mailing lists in order to correct address information and to delete staff who are no longer employed at MIT. This effort will be ongoing. The goal is to reduce unwanted mail by five million pieces

annually. Unwanted mail is currently a major problem for MIT in terms of cost, and junk mail clogs an otherwise efficient system.

Internal MIT mailing lists are maintained in a distributed fashion with no mechanism in place for handling changes across systems and lists. Mail Services will initiate an effort to process changes in an efficient manner. For example, today it is virtually impossible for an employee to contact all the appropriate offices to change their room location for all mailing lists. This work also will include the design and development of an on-line facility which will allow the community to un/subscribe to various mailing lists as they choose.

Mail Services has already negotiated service level improvements with a number of service providers. Additionally, there will be a thorough review of our current USPS address format. It may be necessary to change our addressing scheme to take further advantage of automated sorting equipment and to realize additional delivery services from the USPS.

There have been some transitional problems, with the greatest concern being delayed delivery of mail. The delays were a result of running parallel distribution systems, adjustments in the nature of the work employees must now perform, and delays in the construction of a new central mail facility. Staffing adjustments have been made to correct the delivery problems, and Mail Services is doing sample mailings to test delivery times. In addition, they are increasing their efforts to communicate and get feedback from the community. The mail redesign team is also reconvening to offer their assistance.

Mail-related questions or issues should be directed to Penny Guyer, manager of Mail Services. Ms. Guyer may be reached via e-mail at pguyer@mit.edu or by telephone at x3-6728. There is also a comment form on the Mail team's reengineering Web page.✣

## Professor Kirtley Replies:

Most of the changes described here are not only appropriate but long overdue. In particular, a higher degree of centralization in handling outgoing mail should help to reduce costs.

The Mail Reengineering Team explains the elimination of mail delivery as a way of freeing up labor to deal effectively with outgoing mail. If there are real costs to be saved by doing so (bulk mailing, sorting discounts, etc.), then it would be worth doing even with new employees.

Even as the Mail Reengineering Team recognizes that this higher degree of centralization in outgoing mail can reduce costs, it is imposing, through the elimination of mail delivery, additional costs on the departments and labs. The problem is not just that efforts are being shifted from the mail system to the departments, but that it is being done in a way that can only increase total cost.

How about a compromise: keep the satellite mail rooms, but employ delivery people who would work out of those rooms to hustle mail from them to department and lab offices? If the mail system does not do this, the departments certainly will. What happened with administrative personnel a decade and a half ago (as described by Dean Colbert in these pages last spring) would happen with the mail system.✣
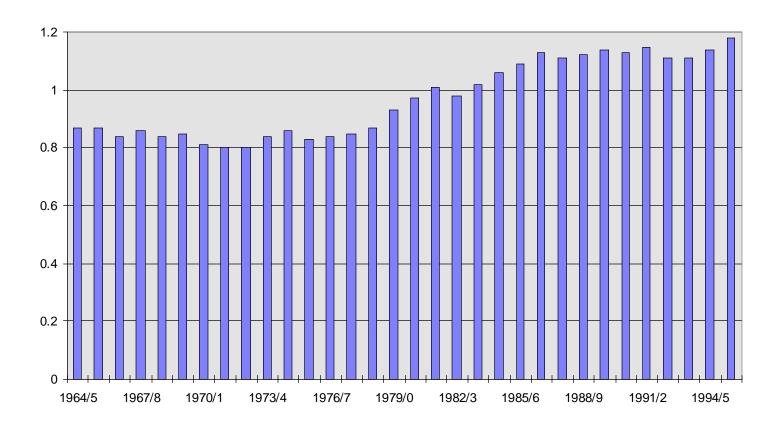
## M.I.T. Numbers

# Women, Foreign National, and Minority Graduate Enrollment AY1973 to AY 1995

| ACADEMIC YEAR | NUMBER OF WOMEN | PERCENT WOMEN | NUMBER OF FOREIGN NAT. | PERCENT FOREIGN NAT. | NUMBER OF MINORITIES | PERCENT MINORITIES | TOTAL ENROLLMENT |
|---|---|---|---|---|---|---|---|
| 1973 | 304 | 9.1% | 927 | 27.9% | 108 | 3.2% | 3,328 |
| 1974 | 318 | 9.5% | 954 | 28.4% | 121 | 3.6% | 3,358 |
| 1975 | 405 | 11.7% | 970 | 28.0% | 151 | 4.4% | 3,468 |
| 1976 | 487 | 13.5% | 1,037 | 28.8% | 155 | 4.3% | 3,603 |
| 1977 | 546 | 14.5% | 1,059 | 28.1% | 178 | 4.7% | 3,774 |
| 1978 | 559 | 14.6% | 1,151 | 30.1% | 157 | 4.1% | 3,824 |
| 1979 | 606 | 15.4% | 1,145 | 29.0% | 147 | 3.7% | 3,944 |
| 1980 | 684 | 16.5% | 1,219 | 29.4% | 150 | 3.6% | 4,146 |
| 1981 | 779 | 17.8% | 1,283 | 29.3% | 174 | 4.0% | 4,384 |
| 1982 | 828 | 18.2% | 1,347 | 29.7% | 140 | 3.1% | 4,541 |
| 1983 | 856 | 19.1% | 1,418 | 31.6% | 145 | 3.2% | 4,489 |
| 1984 | 914 | 19.7% | 1,439 | 31.1% | 143 | 3.1% | 4,631 |
| 1985 | 981 | 20.6% | 1,449 | 30.5% | 141 | 3.0% | 4,757 |
| 1986 | 981 | 19.9% | 1,658 | 33.7% | 139 | 2.8% | 4,920 |
| 1987 | 987 | 19.8% | 1,497 | 30.1% | 144 | 2.9% | 4,979 |
| 1988 | 929 | 19.2% | 1,441 | 29.8% | 154 | 3.2% | 4,832 |
| 1989 | 963 | 20.0% | 1,498 | 31.1% | 159 | 3.3% | 4,822 |
| 1990 | 1,064 | 21.7% | 1,628 | 33.2% | 168 | 3.4% | 4,909 |
| 1991 | 1,092 | 22.0% | 1,674 | 33.7% | 155 | 3.1% | 4,967 |
| 1992 | 1,155 | 23.0% | 1,711 | 34.1% | 190 | 3.8% | 5,019 |
| 1993 | 1,177 | 23.4% | 1,755 | 34.9% | 215 | 4.3% | 5,024 |
| 1994 | 1,154 | 22.7% | 1,744 | 34.3% | 193 | 3.8% | 5,090 |
| 1995 | 1,308 | 24.0% | 1,798 | 33.0% | 229 | 4.0% | 5,324 |
| **TOTALS** | **19,077** | **18.7%** | **31,802** | **31.1%** | **3,656** | **3.6%** | **102,133** |

**Source:  Data prepared for CGS/GRE Survey on Graduate Enrollment**
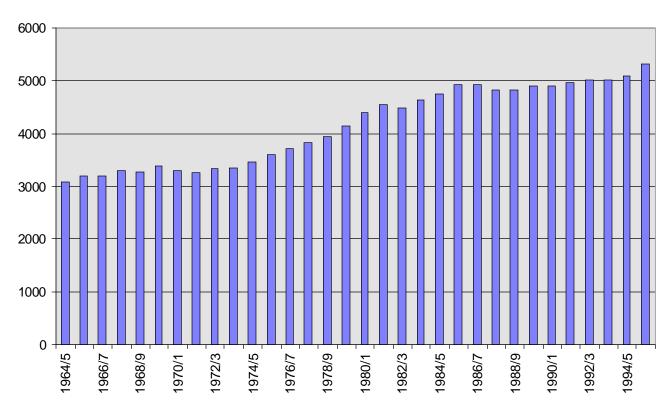
## M.I.T. Numbers

# Ratio of Graduate to Undergraduate Enrollment
# AY 1964 to AY 1995



**Source:  Data prepared for CGS/GRE Survey on Graduate Enrollment**

# M.I.T. Numbers

## Graduate Student Enrollment



Graduate enrollment might be reduced by as much as 10% to 15% by the end of the decade. The extent of this change will depend upon several factors, for example, MIT will no longer be allowed to charge RA and TA tuition to the benefits pool for partial recovery from federal contracts. Thus, both tuition and stipend costs will have to be charged directly to research contracts, increasing dramatically the potential cost to a faculty member of having a graduate student. Some mechanism to reduce the costs to research contracts will have to be implemented in order to continue to make support of graduate students a reasonable, if not an attractive, option. The mechanism that is finally implemented at MIT to reduce the cost of graduate support to research contracts will largely determine the number of students a given faculty member can potentially support. In addition, if federal support for basic research declines by the widely anticipated 25%-33%, then many fewer graduate students can be supported overall within a diminished research environment. It is unlikely that this lost funding will be replaced in total by support from industrial and business interests, even though every effort is being made to expand participation from those sectors.

**Isaac M. Colbert**
**Senior Associate Dean for Graduate Education**