

The MIT Faculty Newsletter

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September 2003

Interview with Medical Director William M. Kettyle

[The following interview with Medical Director William Kettyle [WK] was conducted by the Faculty Newsletter [FNL] on August 6th of this year.]

FNL: Let's start with a little background info, and how you wound up here at the Institute.

WK: I've been in practice in Cambridge for about 25 years. For the first 15 I was at Mt. Auburn Hospital, practicing internal medicine and endocrinology. About 10 years ago I came to the MIT Medical Department. I have had a long relationship with MIT via the HST Program where I've taught endocrine pathophysiology for 20-plus years. I had a long-term chronic job offer from the Medical Department and I finally took them up on the offer to come here. Although I came as a clinician, I've gradually become more involved in administrative matters. For the last three years I have been the medical director. My interests are in patient care and in teaching people how to take care of patients. I continue to teach in the HST program. Although I continue to see patients and to teach, much of my time is now spent on things administrative.

FNL: How many people do you administer? What's the staff?

WK: There are approximately 280 employees and about 100 contractors who work in the Medical Department.

FNL: Full-time positions?

WK: There is approximately 186 full-time staff. The care is provided by 150 full- and part-time clinicians – physicians,
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TEACH TALK

Redefining Engineering

Warren Seering

The distinction between science and engineering is clear. “Science is the process of understanding what is. Engineering is the process of creating what hasn't been.” Such descriptions have been credited to Einstein, Von Karman, and others. I suspect that few here would disagree. The processes of science yield understanding. The processes of engineering yield artifacts.

In practice, engineering and science are sometimes intertwined. This said, the meaning of the phrase “engineering science” is unclear to me. Does it describe a process? Is it a name given to engineering domain knowledge? Is it a branch of science? Most importantly for me as a member of the engineering faculty, what is the relationship between engineering science and engineering?

As I try to decipher the meaning of engineering science, a thicket of related questions appear. Are we preparing our students to be engineers, scientists, or both? How do the objectives differ for our undergraduate and graduate students? What is the role of the Scientific Method in our educational program? What is the Engineering Method? What does it mean to teach engineering?

The following assertions may bring some clarity. The engineering sciences are fields of science whose domain knowledge is central to the practice of engineering just as the biological sciences are fields of science whose domain knowledge is employed by biologists. Exercising the Scientific Method in the domain of engineering yields an understanding of new engineering knowledge. Our engineering graduate students are being taught to be engineering scientists with the ability to understand new
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From The Faculty Chair

Our Faculty Agenda

Rafael L. Bras

The faculty of MIT is a very diverse group who see the Institute through the lenses of schools and units with different cultures and experiences. The above is the overarching conclusion I reached during my visit last school year to practically all academic units of the Institute.

The idea of visiting each unit arose from the realization that the position of chair of the faculty is poorly defined and even less understood, and by the fact that in my 27 years in the faculty I do not recall a visit by a chair, at least to my departments. Steve Graves, outgoing chair, resonated with the idea, and we embarked on a nine-month long trip.

The focus of the meetings was a discussion of issues that could become the faculty agenda over the next few years. Following I will try to discuss six of those issues and attempt to summarize the feedback received. It should be clear that any one of these issues is sufficient to occupy us for some time, and that furthermore the issues are not independent – addressing one will have impact on others. That interconnectivity should be the key to a successful engagement strategy.

Governance

Is the system of faculty governance working? Is the faculty informed and involved in important policy decisions? What are the mechanisms for faculty input in the business of MIT? Why are faculty meetings so poorly attended?

MIT's system of faculty governance has been in place for a long while, dating to the time when the Institute was a fairly small organization. It is quite unique among universities. At MIT, the president of the Institute also holds the title of President of the Faculty. As such, the president chairs faculty meetings and, with the provost, chancellor, and officers of the faculty sets the agenda of the meetings. The current officers of the faculty are the Secretary

(Ken Manning), Associate Chair (Paola Rizzoli), and Chair. All of us were identified by a nominating committee and "voted" into office by the faculty at large – the few that showed up to that particular faculty meeting. The chair of the faculty floats in the organization diagram, under the president, in parallel to other officers of the Institute, but has no staff or budget and her/his appointment lasts for two years. The influence of the chair as a representative of the faculty lies in the fact that he/she sits on Academic Council and the Deans sub group. Equally important, the chair has good access to the president and works closely and collaboratively with him in a myriad of issues, large and small. As chair of the Faculty Policy Committee, the position also influences all the standing committees of the faculty.

Faculty committees are where all the work is done. Some committees are extremely powerful and influential; others struggle with defining a substantial agenda. Less than 10 percent of the faculty are involved in standing committees and even fewer are the number of faculty that consistently influence the decision making in the Institute through standing committees. But at any one time there are probably as many presidential or ad hoc committees and task forces active, which do a significant portion of the important work. These are generally appointed by the president, normally in consultation with the chair of the faculty. The opportunity for the faculty at large to influence the governance exists in the monthly faculty meetings, which are very poorly attended. Discussions during departmental meetings yielded three main reasons for faculty not attending the monthly meetings. Many feel that the issues discussed are unimportant. Many argue that all decisions are effectively made before they reach the floor of the

faculty meeting and hence their influence is very limited. Many state that they are too busy and that the timing of the meetings is inconvenient. I believe all of the above are true. Some are happy with that state of affairs and argue that the committees do their work well and that they will attend faculty meetings when the occasion demands it. Others simply have given up for the reasons stated above, and are somewhat cynical.

My own sense is somewhat in the middle. I do feel that the faculty at large is not participating in the decision process to the extent that it should. I also believe that the governance system works because of a long tradition of inspired and quality leadership, but could become unstable in times of financial and other stress, when difficult decisions need to be made. To make the analogy to New England towns: Is it time to move from a town meeting of the whole to a representative town meeting where the responsibility to represent the opinion of the faculty resides in a significant subset of the faculty?

I invite your thoughts on faculty governance in general. I will revisit the topic in future columns. I have asked the Faculty Administration Committee to do a quick assessment of our system and catalog the models of other institutions.

Faculty Diversity

The Institute has taken a very proactive and visible position in favor of diversifying the faculty in terms of gender and race. The Women in Science report and the more recent companion papers dealing with the four other schools have been influential in and out of the Institute. There is no doubt that consciousness has been raised. Many would argue that we have turned the corner and that biases in hiring, retention, and promotion of women are on the way out. Indeed we have had very successful hiring seasons over the

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past few years, with excellent women joining the faculty. This was particularly true in some of the departments in the School of Engineering. My own sense is that it is too early to claim victory. We still need to prove that we can retain women on the faculty and that we can keep up the hiring pace that will be necessary to make a difference in a reasonable time frame.

In the case of underrepresented minority faculty I believe, and most agree, that we have failed in hiring and in retention. We have not made progress. We need to do better. Pipeline arguments are the most common explanation provided for this failure. The same argument used to be made for the past failure to hire women. I did not believe it then and I do not believe it now.

The great majority of the faculty I met agreed that this is an issue we can and should address, working closely with the Council for Faculty Diversity. Nevertheless, the feeling was not unanimous. The officers of the faculty and the administration do feel that we can and should do something about hiring more minorities and keeping the momentum in the hiring of women.

Promotions

There is nothing that consumes more time, hundreds of person-hours, of administration and faculty deliberation than promotions. There is probably nothing more important. There is universal agreement that the overall quality of our faculty is excellent and that we must keep it that way, hence the promotion and tenure processes are extremely important.

If promotion and tenure are time consuming to senior faculty and administration, they are nerve wracking to most junior faculty. During my conversations with junior faculty I was surprised at their perception of the process. Many see it as less than transparent. Many do not understand the mechanics of the process. Many feel that the signals they receive relative to what constitutes a successful case are mixed and confused.

MIT has three main promotion steps: assistant to associate without tenure (AWOT); AWOT to associate with tenure; associate with tenure to full professor. All the promotions essentially involve outside evaluation letters, inside evaluation letters, personnel record and personal statement, and a written statement by the department head. The promotions are generally vetted by sub-units, senior department faculty, school councils, Academic Council, and

staff, were disturbing. It is clear that we are all working significantly harder than a decade ago. For the most part all faculty feel that pace and pressure is increasing to the detriment of their life. But even more disturbing is the fact that the level of unhappiness and stress reaches alarming levels, particularly for younger faculty and women. There were not enough minorities in the survey to gauge their condition. Almost all faculty responded

The results of the survey distributed last fall on the quality of life of faculty and staff, were disturbing. It is clear that we are all working significantly harder than a decade ago. For the most part all faculty feel that pace and pressure is increasing to the detriment of their life. But even more disturbing is the fact that the level of unhappiness and stress reaches alarming levels, particularly for younger faculty and women.

ultimately the corporation. Except for the Corporation, cases are known to fail in all steps, albeit with decreasing frequency as they move up the decision ladder. Should all promotions receive the same treatment? Should the criteria be the same for all levels of the decision process? Are all those promotions necessary? For example, is AWOT a necessary step? Should tenure imply full professorship? The five schools and even some departments differ on answers.

Finally there is the issue of consistency in the process, particularly from year to year as the decision-making bodies and the institutional culture evolves. Given the necessarily subjective nature of all decisions, this is a difficult and almost impossible issue to resolve. One could argue that the decisions are necessarily absolute judgments and comparisons meaningless. Every situation, like every individual, is unique.

Quality of Life

The results of the survey distributed last fall on the quality of life of faculty and

enthusiastically to this issue. Ironically, few had read the Quality of Life report and even fewer had attended the faculty meeting dedicated to its discussion. Once again, the failures of governance do impact our ability to influence our well being.

The survey identified individual actions that could improve the quality of life of faculty and staff. They range from housing programs to child care. These do have solutions and the provost is trying, through several working groups, to come up with action plans. More difficult to deal with is the pervasive culture of increasing demands on our time. Some argue that our hyperactive personalities are responsible. Maybe partly so, but I believe that we find ourselves caught in a web of internal and peer pressure to respond to too many initiatives and opportunities, or mandates, which we cannot control or influence.

Undergraduate Education

The discussion of undergraduate education took several dimensions. First, is it necessary for all programs to have
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viable undergraduate majors? In fact, times have changed so that in many disciplines graduate education is a necessity and undergraduate education in a particular field is, on its own, of little value. Even in fields of engineering the first professional degree is quickly becoming the Masters degree. Is a major in management science consistent with the philosophy of the professional MBA, which is the core of the business/management education nationwide? In some schools and departments of the Institute, a lack of undergraduate students is the source of much anxiety. That the same unit has a very successful graduate education program does not matter much, particularly in the competition for resources. The reality of MIT is nevertheless that we live and die by research and its inseparable education of graduate students, yet for some units a graduate program alone is not a viable option.

Second, should we worry about the fact that a handful of departments have the overwhelming majority of undergraduates? This imbalance reflects our entrenched belief that students vote with their feet and they are in turn very sensitive to markets, public perception and, more importantly, peer pressure. Selection of majors is highly non-linear. It is very hard to choose a small major when during your first year you never meet (particularly within the housing system) an individual in that major. On the other hand, when four-tenths of your peers are, for example, EECS majors, it is easy to enthusiastically embrace what is, after all, a good program. The quandary we face is that if we truly want to be a university we must maintain a diversity of programs, attracting a diversity of students with varied interests.

Third, and certainly most urgent, is the discussion of our educational core. In essence, the concept behind our educational commons, which defines an MIT student, has not changed much in 50 years. Yes, we have added courses, redefined HASS requirements, changed the content of courses. But basically we still require

largely the same body of knowledge that the Lewis Report defined some 50 years ago. Yet MIT and its students have changed a lot since then. We have all new fields of endeavors. Management science is one of the largest majors. Humanities and social sciences have gone far beyond playing a service role for engineers and scientists. Professional education means something very different nowadays. Demographically our students are very different. The administration and the dean of students are seriously exploring initiating a major effort to review our undergraduate education, particularly its common. Discussions started in earnest during a retreat this past August 20th. The president, chancellor, provost, and all academic deans are involved in the discussion. The Faculty Policy Committee will discuss it September 4th. Input from all of you would be welcomed.

Graduate Education

The discussion on graduate education is also multi dimensional and inseparable from that of undergraduate education. Foremost is what I call the schizophrenia that we have between undergraduate and graduate education and to which I alluded in the previous section. MIT depends on its excellence in graduate education. As a research educational institution it could not survive without it. But in many ways graduate education, the realm of academic units and individual faculty, gets short changed in the discussions at the center of the institution where undergraduate education, in my opinion, dominates. The bottom line is that we must excel in both and nobody is going to compromise on that point. To continue to excel, though, we must elevate the discussions of graduate education and provide a better forum for it at the policy discussions that occur at the highest level of the Institute.

Is the balance between the number of graduate and undergraduate students correct (approximately 6200 vs. 4200)? How can we reconcile increasing sponsored research (generally a very good thing) and the idea of controlling the graduate student

population? How do we keep our competitiveness in terms of cost of graduate students stipends and tuition, in an atmosphere of increasing cost of living for the students and decreasing Institute resources to subsidize graduate student education?

On another topic, we must keep vigilant to maintain our education accessible to foreigners, while at the same time encouraging U.S. citizens to pursue graduate studies, particularly at the doctoral level. This is particularly true in the case of women and minorities that begin to leak out of the pipeline in graduate school.

Final Remarks

It should be clear that we do not lack agendas for the next few years. I expect to initiate efforts to address at least some of the above issues during my two-year tenure as chair of the faculty. Honestly, I do not expect that many of the major issues will be fully discussed or resolved, if there is a need to resolve anything, in the next two years. But jointly we can try. To do so, I beg you to consider getting more involved in faculty governance. Let's make the meetings worth attending and let's have open debates on many of these issues. For that, you must participate.

Underlying all of the above is the unpleasant budgetary reality that we will face in the next two years. The budget crunch is real and serious and you will hear more about it soon. The president, the provost, and many others are working very hard on this issue, and I hope we can arrange for them to address us frequently. I urge you to pay attention and attend at every opportunity, because it will affect all of us and all of us need to cooperate to weather the tight times to come. Nevertheless, I think everybody I have heard is enthusiastic about the direction of the Institute and the opportunities that we have and must take. The budget issue will be resolved and, as usual, we will come back stronger.

Let me end with one promise. I will not write this long again!✦

[Rafael L. Bras can be reached at rlbras@mit.edu]

Committee Completes Newsletter Review

Several years ago, the editorial board of the *Faculty Newsletter* agreed with the administration that the *Newsletter* would be reviewed once every five years by a committee appointed by the president. In March of 2002, President Vest appointed a committee chaired by Professor Steve Graves, then chair of the faculty, to review the status of the *Faculty Newsletter*. The committee report to the president concerned itself with three issues, namely: 1) the need for the *Newsletter*; 2) the governance of the *Newsletter*; 3) resources, in terms of manpower, space, and financing, which are required for the operation of the *Newsletter*.

Subsequent to the submission of the report, the *Newsletter* editorial board had several meetings with the committee and they reached the following agreements: 1) the *Faculty Newsletter* should be continued for another five years; 2) the

governance should remain in the hands of the editorial board, composed of voluntary membership, and administratively the managing editor will be housed in the Office of the President. The two groups also agreed that the editorial board should actively seek new membership. They also agreed to place the *Newsletter* editorial board on the bi-annual faculty Committee Preference Selection form.

In addition, the chair of the faculty will participate in the editorial board activities and the outgoing chair will become an editorial board member. The vice president and secretary of the Corporation will also be a member of the editorial board. The *Newsletter* has been given a new home in 10-207, and there will be a redesign of the printed and online versions.

We are pleased to report that the following faculty members have joined the editorial board: Alice Amsden, Jeanne

Bamberger, Steve Graves, Dave Marks, and Rosalind Williams. Needless to say, due to the Institute-wide budgetary crunch, our budget has been subjected to a regular decrease imposed on us by the administration. We encourage every faculty member interested to join us, and we look forward to an informative and productive five years.

Publication Schedule

The *Faculty Newsletter* will be published five times a year: September, October/November, December/January, February/March, and April/May. Deadlines for submission of material for the rest of the year are: October 13, December 15, February 16, and April 12. Please send all submissions by e-mail to fnl@mit.edu, or to *The MIT Faculty Newsletter*, Building 10-207.♣

Teaching this fall? You should know ...

the faculty regulates examinations and assignments for all subjects.

Check the Web at <http://web.mit.edu/faculty/termregs>.

Questions: contact Faculty Chair Rafael Bras at x3-2117 or rlbras@mit.edu.

First and Third Week of the Term

By the end of the **first week** of classes, you must provide a clear and complete description of:

- required work, including the number and kinds of assignments;
- an approximate schedule of tests and due dates for major projects;
- whether or not there will be a final examination; and
- grading criteria.

By the end of the **third week**, you must provide a precise schedule of tests and major assignments.

Tests Outside Scheduled Class Times:

- may begin no earlier than 7:30 P.M., when held in the evening;
- may not be held on Monday evenings;
- may not exceed two hours in length; and
- must be scheduled through the Schedules Office.

No required classes, examinations, exercises, or assignments of any kind may be scheduled after the last regularly scheduled class in a subject, except for final examinations scheduled through the Schedules Office.

No Testing During the Last Week of Classes

Tests after Friday, December 5 must be scheduled in the Finals Period.

Redefining Engineering

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engineering knowledge. The undergraduate educational process gives students an understanding of existing engineering knowledge and a level of competence at attaining this existing knowledge.

From the perspective of our undergraduate engineering students, the distinction between engineering and science may not be so clear. Most of the engineering coursework for our undergraduates produces understanding (we hope) rather than artifacts. Engineering education may seem like scientific discovery, because learning processes and scientific processes share the objective of creating understanding. To distinguish among the processes being considered here, we can say that:

- Scientific processes yield an understanding of new knowledge (universal discovery).
- Educational processes yield an understanding of existing knowledge (personal discovery).
- Engineering processes yield artifacts.

The primary objective of our current mechanical engineering curriculum is to guide our undergraduates to an understanding of existing engineering knowledge. There is little emphasis on teaching them processes that engineers employ as they apply their knowledge. We are organized to teach the material out of context. It is understood in educational circles that knowledge learned in one context may not transfer readily to another. Therefore, domain knowledge learned in the classroom will not necessarily be available for a student to apply on the job, or even in another classroom. We've all seen evidence of this.

Our bias toward teaching domain knowledge rather than engineering process is not surprising, given the mindset of the MIT faculty as expressed in the 1997 Faculty Survey administered by the Task Force on Student Life and Learning (*MIT Faculty Newsletter*, October, 1997). In specifying elements that define a well-educated individual, 47% of the responding faculty listed "a fundamental base of

science/technology" while only 14% listed "the ability to apply knowledge." This faculty bias leaves our undergraduates ill qualified to be engineers. Knowledge has value for engineers only when they know how to apply it, and processes for applying engineering knowledge are neither simple nor obvious.

If knowledge is most useful for engineering students when it is learned in the context of doing engineering, then the great majority of our engineering undergraduates, who will be practicing engineers rather than scientists, would be better served if we would place greater emphasis on the engineering process as part of the educational experience. What, then, is the engineering process? Some of my colleagues have asserted that the Scientific Method is the basic process of engineering. A quick review of the Scientific Method shows that this cannot be the case. The Scientific Method yields understanding through alignment of a hypothesis with observation. It does not yield decisions that define an artifact. Again with hopes of bringing clarity, I will assert that the Engineering Method has the following steps.

1. Articulate the objective to be achieved.
2. Generate a set of candidate plans for achieving the objective.
3. Evaluate each candidate in light of relevant circumstances.
4. Decide which plan is best suited to achieve the stated objective.
5. Pursue the consequences of the decision.

This Method yields an appropriate course of action if the engineering objective is to transmit torque through a shaft, to reduce the failure rate of a manufacturing process, or to increase the market share of a family of vehicles. It is applied, often recursively and at times in conjunction with the Scientific Method, throughout the pursuit of engineering goals. One can imagine an undergraduate engineering curriculum with one course on each of these five steps. An important difference between the

Engineering Method and the Scientific Method is the outcome. The Scientific Method yields understanding. The Engineering Method yields a plan of action for defining an artifact, typically a device, a system, a procedure, or a service.

To this point my intent has been to suggest that study of engineering processes as well as engineering domain knowledge should be included in the undergraduate engineering curriculum. I have also proposed that integrating the practice of engineering into our undergraduate curriculum will create a more relevant context for learning the fundamentals of engineering domain knowledge, and thus will increase the likelihood that our undergraduates will be able to apply this knowledge when the time comes. Introducing engineering into the curriculum, though, will not be enough. We must also find more effective ways of teaching our students to understand engineering fundamentals, or at least not to misunderstand them.

The assignment of homework problems does have the potential to guide students toward understanding, but the process has serious weaknesses. Homework problems are more like puzzles than they are like engineering problems. As with puzzles, they have a single answer that is known in advance by the puzzle master (and by students who have taken the course previously). Typically there is a routine or algorithm that will yield the single desired solution. The students need only be able to identify the solution templates for puzzles solved previously, align the new homework puzzle with the best solution template, and make small adjustments to produce the desired answer. This pattern-matching strategy allows the students to "solve" the puzzle with little if any reliance on a solid understanding of the domain knowledge. We assign these puzzles because they minimize our workload; they are easy to grade. When students get the right answer, we can delude ourselves into believing that they understand the material. But we

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need only spend a few minutes talking with students individually about the course material to realize how shallow the understanding that they've gained in this way actually is. Students participate in this puzzle conspiracy because they have developed the template matching skills (or access to files of solutions) required to solve these puzzles, but they do not necessarily know how to solve engineering problems. So puzzles are what they want to see. Frequently students express serious reservations and sometimes great displeasure when faced with an engineering problem that requires clarification of objectives, synthesis, the making of assumptions, reduction to a form that can be solved, and interpretation of the result.

For the last few years I have taught engineering mechanics to our sophomores and the product development capstone course to our seniors. This has given me the opportunity to see how much of the domain knowledge that I taught them as sophomores they can apply to engineering problems as seniors. The results are predictably disappointing. Faced with the task of evaluating alternative design concepts, students in the capstone course routinely show little confidence in applying such fundamental notions as control volumes, vector sums, conservation of energy, and momentum principles. It isn't that they missed these concepts when they were taught. Most of them were able to do the homework and exam puzzles in their earlier courses. The requisite number received A's in these courses. But the type of understanding that they achieved by solving homework puzzles has not enabled them to use this knowledge when faced with an engineering problem.

This year several of our senior project groups developed human powered products. A student presenting one of the designs had calculated that about 100 watts of human power would be required to drive his device. When challenged by a faculty mentor with the fact that humans cannot be expected to generate more than 50 continuous watts of power, the student quickly replied, "That's

no problem. We'll put in a transmission." The fact that this one student did not understand the implications of the first law of thermodynamics is not so disappointing as the fact that none of the other students in the section seemed at all troubled by his response. Given the limits of their understanding of the first law, I don't have much confidence in their understanding of the second.

Last year in the sophomore mechanics course, I chose to give my students individual or oral exams . . . One, who did fairly well in answering the questions but who was clearly disturbed by the experience said at the end of the interview, "You didn't tell us we were supposed to *understand* the material. If you had, I would have prepared differently."

Our capstone course is not unique in this regard. A video taken at a Harvard graduation of students and faculty who are unable to satisfactorily answer the question "Why are there seasons?" is shown in educational circles to illustrate the problem (*A Private Universe*, Pyramid Media, 1988). Even more troubling for us is the video from the BBC of some of our own students at MIT's graduation (wearing their robes) who, given a battery, a light bulb, and a piece of wire, don't know how to make the light bulb light (*Simple Minds*, BBC Education, 1994). This limitation on our students' ability to reason about basic course material is well understood by the constructivists in our schools of education.

Teaching methods for addressing the problem are also well understood ("The Contribution of Constructivism," *MIT Faculty Newsletter*, April/May 2001; see also the nice article by Professor David Darmofal, *MIT Faculty Newsletter*, October/November 2002). As faculty, though, we frequently choose to believe that to teach means to reveal concepts to students in a classroom. Can we have taught the material if the students can't use it? Teaching is a profession with its own domain knowledge and processes. Many faculty do not use best educational processes because we are not familiar with them.

This limitation has led some in primary and secondary education to challenge our right to claim to be educators. We have been called kings with no clothing. I find this a bit strong, but it is fair to question whether we are in violation of the American Society of Mechanical Engineering Code of Ethics which states that "a mechanical engineer will not accept a job for which he or she is not adequately prepared."

Last year in the sophomore mechanics course, I chose to give my students individual oral exams as a way to find out how well they understood the material. The results were again disappointing but not unexpected. Though most of the students had solved the homework puzzles, and scores on an earlier written exam had the usual spread, many of the students could not discuss the material with me for more than a few minutes without revealing serious conceptual misunderstandings. Not surprisingly, they were very displeased about the process. One, who did fairly well in answering the questions but who was clearly disturbed by the experience said at the end of the interview, "You didn't tell us we were supposed to *understand* the material. If you had, I would have prepared differently." Then in a follow-up worthy of an MIT student she said, "Now that you've changed the rules, how are you going to change your teaching?" With her beautifully simple query, she inadvertently initiated the Engineering Method by articulating the objective that we need to achieve.

Though it is only part of the solution, teaching engineering domain knowledge in the context of engineering processes is a good way to improve our students' *(Continued on next page)*

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ability to use their knowledge. Bringing engineering processes into the classroom, though, is “messy.” Employing the Scientific Method in pursuit of understanding of engineering domain knowledge should yield essentially the same result for everyone. Thus it is comparatively easy to set expectations and to evaluate against them. Exercising the Engineering Method can produce as many results as participants. Some results will be apples; others oranges, making evaluation time-consuming and difficult. It is no wonder that our faculty are not rushing to bring engineering into our courses despite the potential benefits of doing so.

It is fair to ask, “Do we need to introduce this complexity given that our graduating students will primarily be responsible for the analyses associated with Step 3 of the Engineering Method?” Many of the homework assignments throughout our core courses are already designed to emulate pieces of this step. I would say that these emulations are to engineering what free throws are to basketball. Imagine a coach who prepared his basketball team for the season by having them only shoot free throws at every practice. Among the justifications for this coaching strategy might be the following: The task of shooting free throws is well posed and easy to assign and evaluate; basketball players must be good at shooting free throws; shots taken during a game are free throws to first order; the rest of the game is a straightforward extension of making free throws and can best be learned by experience in a game situation. How will these players feel when the game starts?

While few of us would elect to play for this team, we routinely assign our students to it. When we lead them to believe that doing engineering means calculating answers to well posed questions, we paint a very misleading picture. Engineering is a contact sport. It is played on a very competitive playing field by aggressive, hard-hitting, and highly motivated members of opposing teams. There are winners and losers. Big money is involved.

People get hurt. Successful teams have star players who are richly rewarded. Winning requires talent, commitment, shrewd strategy, and players who can perform their roles under pressure and in well-practiced coordination with their teammates. Having people on the team with a good base of engineering domain knowledge helps too.

A successful engineering team is made up of players with various skill sets. Engineering graduates who choose to build their careers on conducting engineering analyses fall into the industrial category of “functional engineers.” They are complemented by the “systems engineers” who are expected to be responsible for synthesis and system integration. In our senior capstone product development course we see that roughly equal numbers of our students are inclined toward each of these two categories. Successful product development organizations must include members of each. Then there is a third group of students who are good at both functional and systems assignments and who enjoy both. At MIT we call these folks the “system architects.” They are on track to be the industry technical leaders. A large fraction of our seniors are members of this group. Our curriculum, which now primarily serves the first category of students, should be redesigned to better educate the students in each of these three categories.

So is this another attempt to introduce more material into a four-year undergraduate curriculum, opening the fire hose valve even further? (I find use of this metaphor and its accompanying imagery to be unfortunate. It implies that those who would control the valve don’t understand the physics of impedance matching. It’s almost as bad as the MIT school song which celebrates the propensity to “demolish forty beers.”) In fact, I would propose something quite different. Herb Simon has hypothesized that a minimum of 10 years is required for a practitioner to acquire enough “chunks” of knowledge to qualify as an expert in a given field (*Sciences of the Artificial*,

MIT Press, 1996). We should set as our academic goal to have our students qualify as expert engineers by age 30. This gives us roughly a dozen years to cover the necessary material. Since about half of our undergraduates go on to earn Masters degrees, this on average makes us responsible for about five of the years, while our industrial colleagues, who presumably share our goal, are responsible for the others. In this thought experiment I am not considering those undergraduates who will go on to earn Ph.D degrees and become practicing engineering scientists, because their numbers are small. This is not to say that they would not be well served by the curriculum here envisioned.

The task in front of us, then, is to allocate the teaching responsibilities for both domain knowledge and engineering processes among the academic and industrial educators. This will have to be a strongly collaborative effort. MIT, with its extensive network of industrial partners, is in an excellent position to lead it. There should be no preconceived notions about how the teaching of knowledge and of processes should be distributed, about the sequencing of industrial and academic experiences, or about how the academic and industrial educators will interact or even where they will reside. Because our students are being prepared for life-long learning, there should be no rush to cover all the domain knowledge in the first few years. The heavier load will rest on the shoulders of our industrial colleagues, as they have to date been less inclined to see themselves as providing a structured educational experience to these engineering experts-in-training. There will be plenty of learning on all sides as we each work to understand, appreciate, and over time respect the capabilities, limitations, and motivational structures of our two cultures. The alternative is to stay with the existing 12-year plan. I suspect that leaders in engineering education will find a way to do better.♣

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dentists, psychologists, optometrists, nurse clinicians, and physician assistants.

FNL: Health services at the Institute, we believe, are viewed by many faculty and staff as one of the most, if not the most, important quality of life resource. And the consensus of concern seems to be the possibility of the Institute outsourcing health services . . . especially given the budgetary difficulties Institute-wide. What do you see as the broad picture for the future of health services here?

WK: Over the years we've tried to accommodate to the changes that have occurred at the Institute and, at the same time, to accommodate to the changes that have occurred in the medical world around us. The vast majority of care needs can be met here at our facilities. And if we can't meet the need, we try to facilitate the best care in the community around us. So it's important that we maintain good relationships with surrounding medical resources to back up our operation here.

The financial constraints that the Institute is under will have an impact, and are having an impact. They are requiring us to look carefully at the services we offer, so that we're focused on the services that the Institute needs. We need to be sure that we're using our resources as efficiently as we can so that we can maintain the availability of one-site, low-barrier, high-quality care.

FNL: Were you given a specific percentage for budget reduction that all of medical has to take?

WK: We were given a budgetary reduction target. The percentage was seven percent for FY04. A major question is seven percent of what number? A large amount of money goes *through* us and not *to* us. Money, largely Health Plan premiums, goes through us to pay bills for hospital

and other services provided outside the Medical Department. The seven percent reduction was made on an expense base of approximately \$28,000,000 and amounts to about \$2,000,000. In addition, for a number of years the Medical Department has been over spending its budget and dipping into reserve funds. A significant part of our budget-related actions were to further decrease our spending in order to stay on budget. Over half of our expense budget is balanced with income from Health Plan premiums and fees for service. Approximately \$12 million a year, or something of that magnitude, comes from the Institute to support the care of students, job site-related care, and community health activities. With about 10,000 students, we estimate that the cost for the care of students is about \$1000 per student per year.

FNL: Do the students pay that, or does the Institute?

WK: Many schools charge a "Health Fee" to students. At MIT the cost of student health care is imbedded in the tuition.

FNL: So it's all rolled into the tuition, including the graduate tuition.

WK: Right. Supplemental insurance costs are not covered by tuition. This coverage pays for care that cannot be provided at the Medical Department. The cost of this supplemental coverage has gone up dramatically which places increased financial pressure on our students.

FNL: There's been a lot of concern about popular, well-respected doctors leaving the Institute. Lori Wroble in gynecology and Eric Schwartz in dermatology, to name two. So the questions are: are you replacing people, and why do you think they're leaving? Does it have anything to do with a tightening of resources or more work because of budget cuts?

WK: I think many of the personnel changes are the result of changes in personal life circumstances. For example, Dr. Schwartz moved to California and is now married. Other changes have been, for the most part, because of personal issues, lifestyle changes, moves, or something along those lines. However, I think I'd be less than frank if I didn't say that Lori Wroble's departure was in part related to the decrease in resource availability. We have and will maintain on-site services in dermatology and in obstetrics and gynecology. We are in the midst of working out ways of dealing with these issues. We are forging partnerships or recruiting to maintain these important services. Many of our clinicians have been here for many years, and our turnover rate is relatively low. Although that doesn't help make the person who has just lost their dermatologist or their gynecologist feel any better, but compared to other medical practices, our turnover rate is relatively low.

FNL: It seems that women faculty members are most concerned about the health care situation at the Institute, with the desire for more women doctors, for example. One would assume that's an issue aside from any financial question, although they are connected. What with the increase of women at the Institute and that traditionally more doctors were men . . . do you see that at all – the direct need to hire more women?

WK: Absolutely. And one of the issues that we're trying to address now is finding the best way to meet the health needs of women in our community. We had a very interesting meeting with representatives of the women faculty. The meeting was sparked largely by the changes that are occurring in the Obstetrics and Gynecology Service. The changes are fiscally driven at some level, but at another level it's, I think, a process of making sure

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that we are using our resources in a way that best serves this community. In the OB/GYN area it is largely an issue of scale. The birth rate has been relatively stable and relatively low and the fixed costs of taking care of a relatively small number of deliveries are great. And what we need, I think, is to forge a partnership with a group that can spread out some of the fixed costs of coverage. The goal is to continue to have on-site obstetric services and to also have the staffing to meet the GYN needs of our community.

During the discussion with members of the women faculty it also became very clear that there was an important need for enhancement of primary care services for women in our community. We are in the process of thinking together with the women in our community, among ourselves here and with colleagues in the medical community around us, about designing a system that would meet the health care needs of women. Delivering babies is clearly important, but it is one part of the care need. Rebalancing our spending on obstetrics will allow us to redirect resources in a way which I think will enhance the care of women in the MIT community.

FNL: I don't believe there's been a permanent replacement for Dr. Schwartz yet.

WK: We have not been able to find a permanent replacement.

FNL: So it's not for lack of looking.

WK: It is not for lack of looking.

FNL: So why do you think that is? And have there been other people in areas other than dermatology who have come in recent years? And if not, why not? And what can one do to make it more attractive?

WK: We have several new clinicians who have joined us over the last several years. Some join our department as contractors, as opposed to employees. We've been shifting away from hiring very part-time employees. When the care needs require the services of a very part-time clinician (less than 50 percent) we try to meet the clinical need with a clinician who provides services as a contractor – paid for time worked, without benefits. We can often control costs and provide service in a more plastic way by use of contractors. When the need supports more time, greater than 50 percent, regular employment is the preferred route.

FNL: And we don't have those people now? Or are you trying to get more people in?

WK: We have about 150 employed clinicians and about 100 contractors who provide services here at MIT Medical.

FNL: Are those cheaper?

WK: Contractors may be less expensive – largely because we don't have to pay benefits for them. The hourly rate or the contractual rate is, in large measure, market driven. Our commitment to them and theirs to us is relatively less than an employee. In spite of this we have had many very long-term contractual relationships with some of our clinicians.

FNL: That 50 percent figure is important.

WK: Exactly. You need 50 percent effort to become benefits eligible. Retaining good people is something that we're very concerned about and want to be sure that we're making this a comfortable place to work. Workplace environment (an area highlighted in our strategic planning process) has been an important focus of several activities in the last couple of years. With regard to dermatology, the

competition in the outside world is significant. Many dermatologists can make very large amounts of money doing cosmetic things like tucks, laser treatments, and this and that. The competition is great for skilled dermatologists.

FNL: So that particular one you're going to replace. But in pediatrics, for example, my understanding is that people have left and that they're not going to be replaced.

WK: The issues in the Pediatrics Service are also issues of scale. The number of children served in the population is relatively small and we felt, as we reviewed things, that we had the capacity to care for our population of children with a slightly reduced force of pediatricians.

FNL: So the flip side of that point is what about gerontologists? Have we got one?

WK: We have one. You're looking at him.

FNL: You're the gerontologist. Do we need another one?

WK: [LAUGHTER] Most of our internists are very comfortable with the geriatric age group. But there is only one of us who is board certified in geriatrics.

FNL: There has been a lot of discussion the last several years about people who would love to teach at MIT but don't feel they can afford to – the cost of living, the necessity of living further away from campus, what about their kids, and so on. Have you found anything like that in the hiring, that people are hesitant to relocate around here?

WK: The Massachusetts Medical Society provides information that suggests that Boston, and Massachusetts in general, are less desirable places for physicians to

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	MIT Health Plans (Traditional and Flexible)					
	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
Contracts*	4,499	4,588	4,699	4,717	5,070	5,320
Members**	8,768	8,744	8,860	8,764	9,235	9,586
*Individual and Family Plans						
**"Covered Lives"						

work, because of salaries, because of cost of living, because of some issues of job satisfaction, malpractice costs, etcetera. In spite of this, I don't think that it has been a huge factor in our hiring.

FNL: Have you hired mid-career positions or have they been more at the entry level?

WK: We have hired more in the mid-career level than at entry level.

FNL: Do you feel you're able to fill the need with the contractors – for example, in dermatology? Someone could make an appointment to see a dermatologist here. You're not going to send a patient to a private physician somewhere else, are you?

WK: Patient care is obviously the most important thing. To the extent that we can provide the services here, we will make every effort to do that. But when we do have staff deficiencies, we will try to make them up in the community.

FNL: Prospective graduate students and undergraduates are often told when they apply that the medical department is a real resource that other places don't have. From your perspective, would you say that's an accurate statement?

WK: Yes. I think so. I think we have a breadth and depth of services on campus that is at the top of the heap of comparable institutions. Harvard, Yale, and Stanford are the places we compare ourselves to

most frequently. In addition to caring for students these universities also have an HMO or provide medical services for faculty and staff and their families.

FNL: Do those other places have a hospital or infirmary, as we do?

WK: Harvard has an infirmary. Yale has an infirmary. Stanford uses the Stanford Hospital.

FNL: Stanford's is right on campus, though. Let's tie this into the gerontology question. The infirmary seems to be an incredibly important facility for retired and older faculty. But it's something I would think that's particularly vulnerable.

WK: The infirmary is a wonderful resource. It's a place where any one of a number of different types of care can be provided. End-of-life services can be very nicely done there. Immediate post-operative recovery after an operation we can do very comfortably there. We also serve the care requirements of students who may be living in a dormitory or independent living group. For example, a student with mononucleosis, if he or she lived nearby, could go home for a few days and get care. If they live in Cleveland or if they live in Karachi, they can't go home so easily – we can provide the care here.

The Inpatient unit provides a range of very valuable services for our community.

The use of the inpatient unit, however, is at a level that makes the cost per case relatively high. This is a function of the fixed costs of running the facility and a relatively small volume of people using it. Is it the best use of our resources? I think it *is* a good use of resources. In my view the care benefits trump the cost, but we clearly need to be sure we are using this resource as effectively as we can. One possibility is to decrease the size of the Inpatient Unit to the size that will just meet the needs of students and a few post-operative patients. When we analyze that option we find that the gain is mostly in space and very little in dollars because of the relatively high fixed costs of 24/7 staffing around the year. Another option is to think about whether we could use the facility for patients from other educational institutions. On the one hand that has a lot of charm; on the other hand we don't want to dilute our commitment to this community. The Inpatient Unit is an expensive resource but it's a wonderful resource, a valuable resource.

FNL: Do you view this facility in any way being in danger of being outsourced by the Institute or severely cut back in some way, or can the faculty be at least somewhat comforted by the thought that the director would say that this is a resource that all the highest levels of the institution people appreciate, and is likely to be preserved for the indefinite future?

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WK: I think that we will endure for the indefinite future. We play an important role in the life and care of the Institute. But I don't think that this immunizes us from the need to responsibly use our resources. We need to be sure that our costs are realistic and that our services meet the needs of our community.

FNL: So do you anticipate the rate going up for the MIT Plan or the Flexible MIT Plan?

WK: Rate increases are in many, many ways a function of our outside costs, of costs that we don't have a whole lot of control over. Because we are buying many of the services we need for our community in the same medical community in which Blue Cross and the Tufts Health Plan are doing business, we are faced with similar costs for hospital services. The other large driver is the increasing cost of pharmaceuticals. Unfortunately, there will be an increase in our rates. We are working hard to keep that increase as small as possible. Success at some level is a smaller increase. No increase is unrealistic.

FNL: What about the Lincoln Laboratory Medical Center? It's beautiful, but is it cost effective? Are you the director there as well?

WK: Yes I am.

FNL: What fraction of the 280 employees are out there as opposed to here?

WK: There are about 15 clinicians and support staff who spend time at the Lexington facility. Some of these are there for only one session a week or less. There are four to six staff members there on a daily basis. We've always provided on-site job-related care at Lincoln Lab, and so with the opening of this center three years ago, we augmented the services available there. Our hope was that it would build the Health Plan membership. And

we have seen some growth in Lincoln Lab-related Health Plan membership. But the volume there is relatively low. And from simply an economic point of view, it's not very cost effective. From a care point of view, from a community point of view, and from the point of view of our important relationship with Lincoln Laboratory, it has been very successful, but at a high cost.

FNL: What about the changes in psychiatric care? That's been in the news for the last couple of years, the increase in psychiatric attention to the students primarily.

WK: The use of mental health services by students has increased significantly both here and across the country over the last several years. The need for psychiatric care is quite clear and was underscored by the report of the Mental Health Task Force. Their report pointed out a need for more outreach, and called for more easily available mental health services. We have been working hard to try to respond to their suggestions and to meet the mental health needs of our community. We have increased our mental health staff by about four people over the last year, increasing our outreach efforts, and increasing our hours of availability for mental health services.

FNL: But isn't it all one pie, so if you increase that by four, aren't there four other medical people that cannot get a chance to be hired?

WK: We requested additional fiscal support and with a salary supplemental were able to increase the Mental Health staff. So the pie has indeed gotten a little bigger.

FNL: What about the increase in the pharmaceutical co-payment? Is that supporting anything else besides the drugs?

WK: We have a three-tier pharmacy formulary system. These arrangements are designed to nudge patients and clinicians toward lower cost options for drugs. Brand name and heavily marketed drugs are available, but usually at a higher cost to the patient. Our three-tier formulary system is not at all a revenue generating endeavor. It has, however, effectively helped us contain the rapidly rising costs of pharmaceuticals for our Health Plan and for our patients.

FNL: Is there anything else you'd like to add before we close?

WK: We want to preserve the services and the on-site availability that we provide on this campus – for students, for faculty, for staff, for everyone who is a member of the MIT community. We need resources to do this. Our resources come from well-run and cost-effective health plans and from the support of the Institute for the care of students, employees, and for community health activities. In addition to needing adequate resources we must be sure that we are deploying them in responsible, cost-effective ways that meet the needs of our community. We want to focus our efforts and resources where they are most needed and can be most effective. We are both part of and insulated from the medical community around us. Medical costs are rising relentlessly. The challenges are significant and the need for focus and continued monitoring of the needs of our community is great.

I realize that some of the changes that are happening and that we are making are having a significant effect on many members of our community. Changing clinicians and changing jobs is never easy. We are trying to keep the changes to a minimum and the service to our community at a maximum.

FNL: Thank you very much.❖

Art In Education, Education In Art

Alan Brody

[The following is excerpted and adapted by Associate Provost for the Arts Alan Brody from a chapter he wrote for Passion and Industry, (Harvard Graduate School of Education, 2001).]

There has been an alarming amount of press over the last five years about studies confirming that arts education increases test scores in math and reading. More recently there have been studies of those studies that question the original studies' results. It's becoming quite an industry. What nobody seems to notice is that all these studies are beside the point. I doubt that many people would take seriously a study to prove that reading Shakespeare raises math scores, or that immersion in mathematics is a sure bet for writing better papers on the color imagery in *The Red Badge of Courage*. Even if such a study did exist (and I wouldn't be surprised) its absurdity would be patent. Literature and mathematics afford us different ways of apprehending our world and, for young people especially, ways of owning it. Neither course of study needs to be of explicit service to the other. Everyone recognizes the discreet contributions of literature and mathematics to consciousness. Art, too, gives us a vocabulary for knowing, one as unique and elegant as the other disciplines. Art gives us a way of knowing our world physically, of engaging our bodies and senses, as well as our minds.

The idea of the arts as an educational enterprise in its own right, on a par with the "traditional" disciplines, is troublesome to many because of many myths, misconceptions, and prejudices.

The myth of talent, for instance, has been a major factor in marginalizing art in education. Talent can't be taught, we're told, so it is futile to teach art. The logic is spurious. Genius cannot be taught either, yet mathematics and the sciences are taught as a matter of course. Perhaps the reason for this singular myopia is a growing confusion between the arts and the

entertainment industry. Parents tend to believe there is no purpose in studying any art unless their child is going to be a star – or at least make a living at it. Only the most gifted will survive in the marketplace, and as a consequence those young people who may simply love an art are denied access to it. Not everyone who studies an art should be expected to have a life in that art. But a young person who studies an art

they do not feel inadequate. Perhaps if we made the arts as accessible as sandlot baseball the producers of the most sophisticated art would be able to stop worrying about where their audience will come from.

A friend once observed that all educational institutions, including colleges and universities, have a twofold mission: to educate and to socialize. He pointed out

The arts help develop a tolerance for ambiguity. They tell us that there need not be one right answer to some questions, and that sometimes the question is more important than the answer, that a symbolic image will never stop revealing its meaning while an iconic sign is fixed.

will have that art in his life forever. Art education need not be confused with vocational training.

We know very well that many young people pursue sports with a passionate commitment that has nothing to do with a future in the major leagues. They play for pleasure and the excitement of mastering a difficult and demanding activity, often without even being aware that this challenge is the very fuel for their passion. In the process they come to appreciate the subtlest nuances in execution. It makes them avid fans when they grow older. Theatres, concert halls, and museums are constantly voicing concern about where their audiences will come from in the next 20 or 30 years. They spend huge resources devising "outreach" programs in the hope of developing young audiences. Ball parks and stadiums don't have such concerns. Their crowds do not feel like strangers, ill equipped to appreciate the event they've chosen to witness. Fans come to a ballpark secure in their own critical abilities. They have a history of hands-on experience and

that these are contradictory goals. If we are truly educated, we have the tools to question even the most sacred social customs and institutions. If we are truly socialized, we embrace the status quo and jeopardize our chances for deeper inquiry. Too often socialization wins out. The practice of arts education comes close to resolving this contradiction.

Training in the arts teaches students to see and hear the world from their individual perspectives. It guides them to their own, unique voice and vision and gives them the tools with which to share what they've found. The visual artist questions the brown and green crayons she was given early on to draw a tree. The actor develops an instinct for authentic action that reveals the behavior of characters on sitcoms as lifeless clichés. The musician soon gets bored with the simplest, most accessible tunes and harmonies. With this kind of orientation it isn't long before these young people are prepared to challenge other forms of received wisdom. They have, indeed, been educated.

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Their socialization springs from the need to share what they have found and made with others. At a time in their lives when the pressures for conformity are at their greatest, students who study and participate in the arts discover their capacity to celebrate diversity and to share their uniqueness. Each recognizes his or her contribution to that celebration through the specificity of vision and voice.

In systems where quantitative results are becoming more and more the only standard of measurement, the arts focus on the sensuous, qualitative nature of experience. They help a student find value in non-linear thinking, in the idea that one can understand by correspondence as well as cause and effect, and that our dreams can tell us things quite different from but no less valuable than what tables and graphs can.

The arts help develop a tolerance for ambiguity. They tell us that there need not be one right answer to some questions, and that sometimes the question is more important than the answer, that a symbolic image will never stop revealing its meaning while an iconic sign is fixed. They tell us we can celebrate our bodies and have the world through them as well as our minds, that the pressure of charcoal on paper can contain revelations very different from the tapping of computer keys. Music and acting teach young people to listen with care. The visual arts teach them to see with imagination – which means to see what is really there.

And the arts teach discipline, rigor, and realism. The young pianist cannot sit in her room and imagine winning competitions. She has to be in the studio responding to the demands of her

instrument, her own ear and her sense of the beauty of the music, all against the intractability of her own fingers. The dancer goes to the limits of his body's possibilities and then works to surpass them. The poet learns that passion cannot communicate without form and that pure form is lifeless without some emotional commitment filling it. And when these students achieve a level of competence, no one has to tell them. They can hear it in their own ears, feel it in their own bodies, test it against their trained sense of truth and emotional authenticity.

Then again, Jay Keyser said to me when I first arrived at MIT, "Sometimes the best reason to study or practice something is because it's beautiful." Jay does have a way of clearing through the underbrush.♣
[Alan Brody can be reached at brody@mit.edu]



Why Compose?

Peter Child

[On October 29, 2002, composer Peter Child, professor of Music and MacVicar Faculty Fellow, delivered a presentation to the Music and Theater Arts Visiting Committee entitled "Why Compose?" The talk followed a recital of his music in Killian Hall, and it was illustrated with recorded examples of his music. The complete paper, including the recorded excerpts and links to the complete pieces, is available online at the Faculty Newsletter Website <<http://web.mit.edu/fnl>>. A brief summary is given here.]

In this presentation I try to describe what happens when I compose a piece of music, following the process in a couple of concrete examples. I focus on two aspects that are particularly important to me: feeling, and technique. An embryonic compositional idea is generally rich in feeling, one

that is elaborated in the growth of the idea into a piece. How does that musical feeling relate to my feeling, as the composer, or to your feeling, as someone listening to the piece in performance? Similarly, an embryonic musical idea is generally rich in technical implication, motivic, harmonic, rhythmic, and so forth.

Working these out is generally at the front of my mind in the compositional process. Complex as they are, however, emotional and technical preoccupations strike me as only the surface aspects of the compositional process. I try to get at the much more difficult aspects that lie beneath, the irreducible essence that I think accounts for the compulsion to compose. This leads, in the end, to some speculation about the arts in general, what separates them from the humanities, and the relevance of these observations to us as educators.♣

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MIT Poetry

OF TWO MINDS

But man, there's no boundary line to art.
 —Charlie Parker

1.

The young Fibonacci, with downcast eyes and open mouth,
 His abacus under his arm,
 Scuffs through the dust of the streets of Bugia,
 Sweats under the fire of the Arab sun.
 Thin boys wave their arms and jeer:
 The Blockhead, the Bighellone,
 Outcast because of one eye that turns inward,
 Fibonacci, son of the Simpleton Bonaccio.
 And Pisa is very far away.

At home he stares, heavy-lidded, into the fire
 And dreams a gift of numbers.
 He dreams rabbits, leaping from the fire in pairs,
 A predictable sequence—
 One pair, two, three, five, eight, thirteen,
 And on without an end,
 Each number the sum of the preceding two,
 Increasing by the magic ratio of the golden mean,
 The sequence a graceful logarithmic spiral—
 An unbearable glimpse into infinity
 That he will one day catch between the covers
 Of the *Liber Abaci*.
 Both nostrils filled, one with the dark snuff
 Of nothingness, one stuffed with light,
 He nurses a sneeze.
 Unborn stars lie buried in the mottled jelly of his eye,
 And in the eye a tear, indifferent,
 Reflects the world, reduced, warped and wobbling,
 The curve of its convex edge
 The fragment of a spiral.

2.

In the galaxies of outer space,
 Arms of stars twirl outward
 In spectacular spirals;
 With held breath, I watch the night sky
 For a comet, waiting to see its graceful tail
 Spiral away from the sun in a blazing curve.

Released by a collision at the sun's core,
 A neutrino sails through space toward earth,
 Arrives in eight minutes, a quick trip,
 Ducks into a trap set to catch it,
 A tank five thousand feet underground
 In the Homestake Mine in Lead, South Dakota,
 Bumps an atom of chlorine,
 Liberates an electron
 Whose curling track
 Sprays outward in a delicate spiral.

Skullful of green wonder
At the whorl of a fern tip
Forcing its way through leafmold,
I stare at wonders seen and thought of,
Known and imagined:
A snail's spiral shell,
The whorl of seeds spiraling from the center
Of the drooped head of a sunflower,
The marred bark of a young dogwood
Scarred in an ascending spiral
By honeysuckle trying to get ahead,
The towering corkscrew horns of the African Kudu
That must be hunted alone,
The open secret of the ear's coiled cochlea,
The lonely spiral growth of streptococci
In a swollen throat.
The serpent coils savagely on itself,
Tries to swallow its tail,
Fails, an ecstasy of rage,
An eternity of escape.

As the sun arcs over the horizon
And darkness settles thick and gentle as an eiderdown,
And a narrow moon slices the sky,
Its curve clean as the lid of an eye,
On a stretch of earth that seems more flat than not
I lie back, looking up and out,
Feeling small, and feel
The arc of the earth's curve
In the small of my back.

3.

The dusts of Fibonacci's bones
Sift and swirl in spirals
As the planet whirls and heaves.
There is no rest.
Yet somewhere there is a room,
A room with walls that spiral
Toward its center, a space
Sucked clean of time,
A place where mystery takes its ease
And hides its face.

–Rebecca Blevins Faery

Letter Questions Institute ROTC Policy

[This letter was originally written in response to an article which appeared in The Tech on June 18, 2003 (“ROTC Discrimination Statement to Change,” by Keith Winstein), and was published in The Tech on July 9, 2003. I received several e-mails in response suggesting that the report of the original article about how the policy was being administered was not correct, but I have not tried to investigate this myself and The Tech has not in any way retracted its initial story. All of my own concerns were not addressed in these e-mails. Thus the issues raised in the original article and in this letter seem to be of continuing relevance, and for that reason, I accepted the offer of the Faculty Newsletter to reprint my letter at a time when more of the faculty would be on campus and likely to pay attention to it. I have tried to correct some of the grammatical errors in the original text, but have not otherwise changed it.]

To the Editor:

The article by Keith Winstein on the changes in the Institute’s ROTC policy, and the comments of the faculty and administration which he quoted, do not accurately reflect the policy which was adopted by the faculty, as I (as a gay member of the MIT community) understood it. For me, the efforts to change the policy in Washington were not the most important element. Far more important was the effort to make sure that ROTC did not generate and maintain an ethos which is antagonistic to MIT’s open and tolerant academic culture, and, in fact, that as much as possible the broader culture of MIT permeated ROTC.

Latent (and not so latent) homophobia within ROTC and its potential for infecting the rest of the Institute was of paramount concern (given the policy toward gays in the military), but this was part of a broader concern about the possible clash between military and academic values. The broad policy was captured by the term “tight embrace”; the idea was to draw ROTC closer to MIT, not to distance MIT from it.

The policy of tight embrace was a practical accommodation to the Congressional threat to cut off all military funding to universities which severed connections to ROTC. Given the magnitude of military research at MIT, and its importance in a number of research and teaching programs, the threat went to the very foundations of the institution. But tight embrace was, for these very reasons, not simply an accommodation to an unpleasant reality. Precisely because of the importance of military research on campus, the Institute has always faced the problem of the clash between the military ethos and the academic culture. It has over the years evolved a series of institutions and procedures for managing and resolving that conflict in a way which has insured the scholarly integrity of its programs. It is for that reason that ROTC was still present on campus when the issue of gays in the military arose. In the Viet Nam era, when other universities were quick to eliminate their ROTC programs, the MIT faculty reviewed the ROTC oversight process and found that it had been successful in maintaining a program that was consistent with the Institute’s basic mission. That same faculty, in the same period, reviewed the Draper labs and recommended severing the connection between the Institute and Draper, basically because it was felt that academic values had not been, and could not be, preserved there. (The Corporation, at considerable financial sacrifice, then sustained the faculty vote and carried out its recommendation). Tight embrace is an extension of this tradition.

From this point of view, there are four key elements to the tight embrace policy. First, every military candidate for a position at ROTC is interviewed by the faculty committee; in the interview the basic policy is explained and the candidate is required as a condition of appointment to agree to accept the letter and the spirit of the policy, by not tolerating homophobic speech or behavior in the activities which he or she supervise. Second, ROTC classes are to be open to all

members of the MIT community whether or not they can actually participate in the program itself. Third, ROTC will try to develop joint classes with other parts of the Institute on subjects in which they share a common interest. The last component is the “reinsurance” through which MIT is committed to provide financial support equal to that provided by the ROTC program to any student who loses his scholarship because of the military policy of expelling open homosexuals.

ROTC faculty are nominated by the military service but must be approved by the ROTC committee of the MIT faculty. When I was a member of the faculty ROTC committee, every candidate was in fact asked what was then called “the question” and agreed to the Institute’s policy. I do not know whether this is still the case, but it certainly should be. ROTC has worked to develop joint classes with other parts of the Institute. The comments of one of the officers in your article suggest, however, that ROTC’s own classes are not open to all students. And the fact which you report that the reinsurance program is not widely publicized and ROTC students are not all advised of its existence is certainly not consistent with the spirit of tight embrace policy. Clearly there are problems with the policy as currently administered which need to be corrected.

In a week in which the rights of homosexuals to marry has just been recognized in Canada, it is hard to say what is politically realistic. But I at least did not ever think that pressure from MIT would change military policy on the issue of homosexuality. I did think that, if effectively implemented, the policy of tight embrace would protect the Institute generally and the gay members of the Institute community specifically against the broader impact of that policy on campus, and I continue to do so.

Sincerely,

Michael J. Piore

David W. Skinner Professor of Political Economy

Course Websites and Community Values

Hal Abelson

"I came to MIT because it was a free, open environment. It's not that any longer. I wouldn't enroll in the kind of place MIT is becoming."

This complaint from a graduating senior last spring was in reaction to the increasing fraction of MIT course Websites that are restricted so that only students taking the class can view them. When Websites for MIT courses began appearing in the '90s, almost all of these were openly viewable by anyone at MIT or around the world. There are still many open sites, but the overall picture is changing as we deploy institutional support for course Websites. Last spring, MIT's centrally supported Stellar system <<http://stellar.mit.edu>> hosted about 225 course Websites. Of these, two-thirds had access restricted so that they were viewable only by students in the class, or with special permission from the instructor.

It's easy to shrug off these restrictions in the name of instructor choice, saying that it's up to each instructor to determine who can view the Website. MIT course management systems give instructors control over site access, both for the site as a whole and for fine-grained control over access to the individual parts of the site.

But granted that access is determined by instructor choice, it's curious to contrast Stellar's Website access patterns with Sloanspace <<http://sloanspace.mit.edu>>, the course management system for the Sloan School. Last spring, about 125 of Sloan's 160 courses had Sloanspace Websites. Of these, five percent required explicit permission to access the site. The rest were open to everyone in the Sloan community.

Why do Sloan faculty choose to open 95 percent of their course sites to the Sloan community, while two-thirds of Stellar sites are restricted to class members only? Are there crucial differences in the technical designs of the two course management systems? Is there something special about the faculty support provided for one system versus the other? Or does

difference lie not in technology at all, but rather in Sloan's self-image as a community compared with that of MIT as a whole?

We speak a lot at MIT about community, about the unique nature of the MIT community, and about things we can do to enhance our community. Is how we share course information across the MIT community a proper part of that discussion? The physical space a community inhabits

Why do Sloan faculty choose to open 95 percent of their course sites to the Sloan community, while two-thirds of Stellar sites are restricted to class members only? . . . Should MIT students be permitted, even encouraged, to browse course Websites at will, or should this require instructor permission?

has enormous influence on the nature of the community. The same is true for information space, where a Web-based collaboration tool like a course management system becomes a lens for revealing community values, as well as a lever for changing those values.

"Out there on the electronic frontier, code is the law," wrote Bill Mitchell in *City of Bits* (1995). Larry Lessig took up this theme in *Code and Other Laws of Cyberspace* (1999) to explain that a computer system's information architecture serves as a kind of regulation. The default system configuration, the difficulty of selecting one setting rather than another, even subtle cues in wording or presentation, can shape people's behavior in an information society just as effectively as laws and policies formally enacted.

What Website access policies do we want? Should faculty be able to casually

examine each others' course materials on the Web? Should MIT students be permitted, even encouraged, to browse course Websites at will, or should this require instructor permission? Or alternatively, should course sites be private resources for the class students and faculty, that privacy helping perhaps to reinforce the intimacy of the classroom experience?

Perhaps there's no need for community access to course Websites. After all, MIT has made an institutional commitment to public access through OpenCourseWare. OpenCourseWare sites aren't actual classes in progress – they've been edited so that MIT can publish them to the world – but sites designed for the general public might be adequate for MIT community members not in the class.

Roz Williams, in *Retooling* (2002), describes the dilemma faced by the MIT Office of Information Systems in designing a class-list management system for the registrar. The very question of creating a central data service forced the group to articulate institutional policy about who is an official member of an MIT class, and, as Williams writes, "shine a light on inconsistencies between practices, behaviors, and policies."

With course management systems, we're shining that light onto practices that go beyond the registrar's official list: Are our classes experiences for class members only, or do they have a role as community resource, and if so, for which community? How widely is course information shared across departments, schools, and the Institute? Should members of the MIT community have special access to course materials that we do not publish to the world?

And as we deploy these systems, we're implementing policies on sharing and openness that are shaping the kind of place MIT will become. I'd like to think that we'll remain the kind of community where my student would still want to enroll. ♣
[Hal Abelson can be reached at hal@mit.edu]

OpenCourseWare Update

The Road Less Traveled

**With the publication of 500 courses,
MIT stakes a leadership position on open sharing**

Dick K.P. Yue

*“Two roads diverged in a wood,
And I – I took the one less traveled by,
And that has made all the difference.”*

–Robert Frost, 1874-1963

A few years ago a team of faculty, administrators, and students on the MIT Council on Educational Technology (CET) found itself in the tangled woods where higher education converged with the Internet. The question? How should MIT position itself in the charged world of e-learning?

After more than a year of study, dialogue and deliberation, the recommendation in fall 2000 was that MIT should take the road less traveled: to launch OpenCourseWare (OCW) wherein MIT course materials that are used in the teaching of almost all undergraduate and graduate subjects would be made available on the Web free of charge, to any user anywhere in the world.

At a time when businesses and universities alike were caught in the “dot.com” frenzy, trying to make their fortunes through distance education, the Institute stepped off the path that in the end led many to financial failure. Instead, OCW took MIT in the opposite direction. As MIT President Charles M. Vest told *The New York Times* in April 2001, the idea of OCW was “counter-intuitive in a market-driven world.”

Critics thought the proposal “crazy” at that time, but OCW was not an isolated idea. It grew from a process that examined how technology could support MIT’s educational mission, and how the Institute might exercise leadership in the Internet Age. Leadership meant taking chances and setting an example, and with OCW, MIT unquestionably took leadership. OCW would not have been happened without the vision and courage of the Institute’s

senior administrators, and the faculty’s remarkable dedication to education and MIT’s mission.

With the official launch of the OCW Website this month with 500 subjects from all five MIT schools and 33 academic disciplines, what started as a vision is becoming reality. The Mellon and Hewlett Foundations and MIT provided the needed funds; the OCW organization provided the execution; and more than 450 faculty have contributed their course materials. A perusal of <http://ocw.mit.edu/> reveals a remarkable showcase of the material we use in our undergraduate and graduate education: lecture notes, problem sets and quizzes, multimedia simulations, and a sample of video lectures. The goal is to put approximately 1,800 subjects – virtually all the subjects the Institute offers – on OCW by 2008.

Even before the official launch of 500 subjects, OCW’s pilot site with its initial 50 subjects received worldwide attention and interest. In the past year, the site received more than 110 million hits from over 200 countries, and generated 7,500 e-mails from around the world. Those e-mails tell us that home-schooled children in rural Kentucky – 220 miles from the nearest library – are benefiting from access to MIT materials; and students across the United States are augmenting their learning through Gil Strang’s video lectures, Chiang Mei’s wave simulations, and Arnold Barnett’s lecture notes. Internationally, OCW materials have been translated into 10 languages (that we know of, including Spanish, Portuguese, Mongolian, Ukrainian, and German); and the education ministries of several countries are involved in promoting OCW to their own universities. There is also the heartwarming story of how educators from a persecuted religious minority in the Middle East,

denied access to higher education in their native country, are using MIT course materials to support an underground university for their members.

In addition, the “MIT OpenCourseWare Update” e-mail newsletter now boasts almost 11,000 subscribers, a self-selected audience that will be valuable in assessing the impact of OCW.

Here at home, faculty have become more aware of what their colleagues teach, while students have welcomed the syllabi and lecture notes available on OCW. Some of us have been recognized by peers at other universities for our OCW Websites, and in some cases this has led to new teaching and research collaborations. Many MIT faculty proposals to agencies such as the National Science Foundation now mention OCW as one of the ways pedagogy and research at MIT is having a broad impact.

With all this good news, we still have a long way to go to the publication of 1,800 subjects. If you are one of the hundreds of faculty who have already contributed your materials to OCW, I say “Thank you!” If you are not yet participating, consider the benefits of openly sharing your work through OCW – benefits for users of OCW, but also, the potential rewards for you in the creation of a visible Web presence for your teaching, and in increased opportunities for collaboration. The effort is minimal and the entire OCW staff is dedicated to making your participation as smooth and easy as possible.

For many of us, the ultimate vision for OCW is that MIT, by setting an example for how a university might rethink its mission in the Internet Age, will inspire many other institutions to openly share their educational materials. In establishing

(Continued on next page)

Incentives?

John Hildebidle

How often and how clearly we have been told – by the near-legendary “Silbey Report” on student life and learning, by assorted deans and other administrators, by various faculty committees – that MIT sorely lacks informal, outside-the-classroom contact between faculty and students.

Perhaps so. But not, I must argue, at the close of the term. The *informal* aspect covers the frequency – very nearly the universality – of final-class food-oriented gatherings. As I walked the corridors of Building 14 on the last day of classes last spring, I was torn with guilt; I may well have been the only member of the faculty who normally teaches in that building who did not even bring in a box of Dunkin’ Munchkins. Tea parties, ethnic feasts, and the predictable (but always popular) pizza: to mimic the title of that movie of some years ago, “joy seemed to reign supreme.”

But then there are those elaborate celebratory dinners sponsored by programs, departments, laboratories, and the like, honoring prize-winning seniors, long-time participants, as well as the occasional faculty

hanger-on, in which category I managed to find myself, three times. The cliché is, of course, “If you feed them, they will come.” The same rule applies to me.

But it was not just the food (none of the meals were Ritz-quality, after all), nor the formulaic commendatory speeches (how many ways are there to say, “Nice job, guys?”). It was the fact that, at each gathering, there were students I had gotten to know, in some guise or other, over the course of their MIT careers. Some were students who stood out from the usual, high-quality crowd. Some were present or former advisees – the particular connection really didn’t matter. We had achieved (at least on my side) a certain degree of friendship, and (in the case of those about to graduate to other worlds and other endeavors) I would in fact miss them.

All of which came to mind as the CUP and the CSL pondered the weighty and complex issue of mentoring/advising, which has been a major joint focus for some months. One issue that was foregrounded was that of *incentives*. What, it was wondered, would persuade people who are already inhumanly overworked

to take on the time- and energy-consuming task of advising younger colleagues and students. I don’t mean to oversimplify the problem – it is real, and difficult to resolve. But one thing seemed not to be put on the table: contact with the brightest adolescents in the known universe is simply *fun*. I risk, I know, sentimentality – but so be it. As I “worked the crowd” at the Athletic Department banquet, shaking the hands of members of the women’s soccer and hockey teams, and the men’s track and football teams whom I knew, I found myself musing, aloud, on the issue of why I was spending an evening away from home. “Well,” one student kindly – and I think accurately – reminded me, “you had to come to this. You’re family.”

I wonder: is not the friendly and informal contact with intelligent and imaginative younger people the major reason why one undertakes a career as a professor? Heaven knows there are less stressful and more remunerative paths most of us might have taken. Neither of my parents could ever figure out why I didn’t go to law school. ♣
[John Hildebidle can be reached at jjhildeb@mit.edu]



The Road Less Traveled

Yue, from preceding page

a model and standards, we make it easier for others to follow MIT’s example, and perhaps, even do it better. Already, we have received inquiries from private and public universities in the United States, Canada, Europe, and Asia, asking, “How might our institution do the same?” The potential impact of a worldwide network of “opencoursewares” could be truly profound.

There is a Chinese proverb that roughly translates to “Throw out a brick to attract a jade.” In taking the road less traveled with OCW, MIT has offered educators around the world a new way of thinking about open sharing. Our hope is that one day, open sharing will be a road well traveled, a road covered with jade. ♣

[Dick K.P. Yue can be reached at yue@mit.edu]

Read more about the worldwide impact of OCW in *Wired Magazine* at <http://www.wired.com/wired/current.html>. If you would like to participate in OCW, please contact Jon Paul Potts, the OCW communications manager, at jpotts@mit.edu or 2-3621.

While You Were Away . . .

Janet Snover

[Special Assistant to the Executive Vice President Janet Snover highlights some administrative news from over the summer.]

The MIT-developed Website, the Virtual Environmental Campus <<http://www.c2e2.org/evc>>, is one of the sites that the Environmental Protection Agency has launched to help colleges and universities improve their environmental compliance and performance. The EPA's New England office announced that MIT's site "uses an engaging, intuitive format to highlight potential environmental issues in nine campus areas." These locations include arts/theater areas, cafeterias, dormitories, drains/sewers, grounds/vehicles, labs, medical areas, power plant, and waste storage. The site is hosted by the Campus Consortium for Environmental Excellence, C2E2, a consortium of colleges and universities dedicated to improving their campuses' environmental performance through professional networking. MIT agreed to develop the site as part of a settlement of an enforcement case with the EPA that was concluded in 2001.

- The Sloan School of Management is merging its Sloan Fellows and Management of Technology programs into one executive education degree program. Beginning next June, the new name will be the MIT Sloan Fellows Program in Innovation and Global Leadership. The program includes a flexible scheduling option that will allow executives to earn their Sloan degree without taking a year off from their jobs.

- Kenneth D. Campbell, the director of MIT's News Office for the last 17 years, retired on June 30, 2003. Following a nationwide search, Arthur Jones of Washington, DC was selected as the next director. Mr. Jones has more than two decades of experience, including work as a reporter, television news manager, as well as local government service in communications for both the City of Boston and the Governor's Office. He also served as deputy press secretary to President Bill Clinton.

- Over this Labor Day weekend, the Human Resources-Payroll Project team implemented the HR module of our SAP software. What this means is that the HR department will stop using its old information system and will use SAP instead for all HR transactions. An extensive data verification and cleanup effort by administrators in the departments, labs, and centers (DLCs) preceded the switch from the old to the new HR system. Although administrators in the DLCs are not yet utilizing SAP directly for their HR work, they are using new and revised forms for communicating with the HR department.

- For this academic year, the fee for a regular commuter parking pass increased to \$518 from \$466 last year. Information about parking, MIT's 50 percent MBTA subsidy program, shuttles, and alternative transportation choices is available online at <<http://web.mit.edu/parking>>.♣
[Janet Snover can be reached at jsnover@mit.edu]



Thank You for Another Great Year

Louis Alexander

[Director of Alumni Education Louis Alexander offers thanks to the faculty for participating in Alumni Association programs.]

Every year, the MIT Alumni Association calls on Institute faculty and administrators to speak at Association-sponsored events both on campus and at alumni group meetings worldwide. Every year, the faculty and

administrators answer our calls with great generosity. This past year was no exception with 105 different faculty and administrators giving of their time to make presentations.

This kind of intellectual and personal connection with MIT is one of the most important services the Association can offer alumni, and our deep appreciation to those who help make it possible cannot be emphasized enough. We hope these

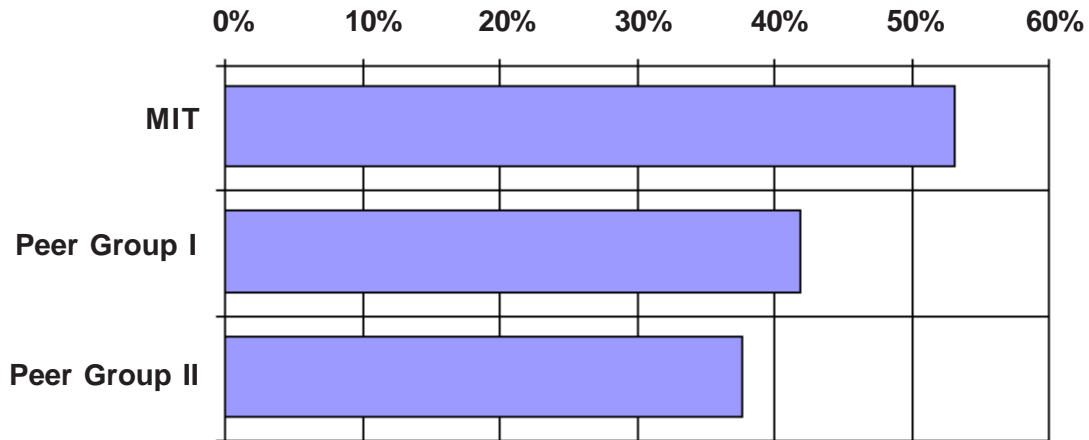
connections are as enjoyable to the faculty and administrators as they are to alumni. Please see the online version of the *Faculty Newsletter* <<http://web.mit.edu/fnl>> for a complete listing of those people who made presentations this past academic year. We look forward to involving as many faculty and administrators this next year, if not more.♣

[Louis Alexander can be reached at lalexan@mit.edu]

M.I.T. Numbers

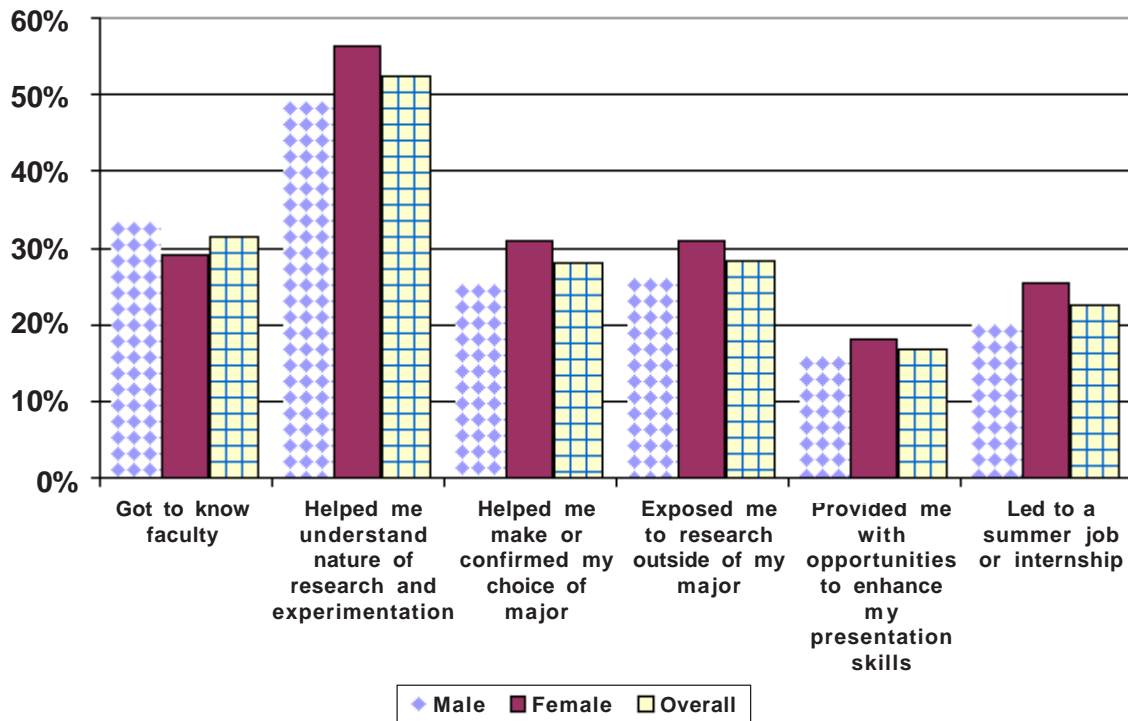
Undergraduate Participation in Research *from the Spring 2003 COFHE Survey*

Percent of Students Participating in Research



Outcomes of UROP Participation

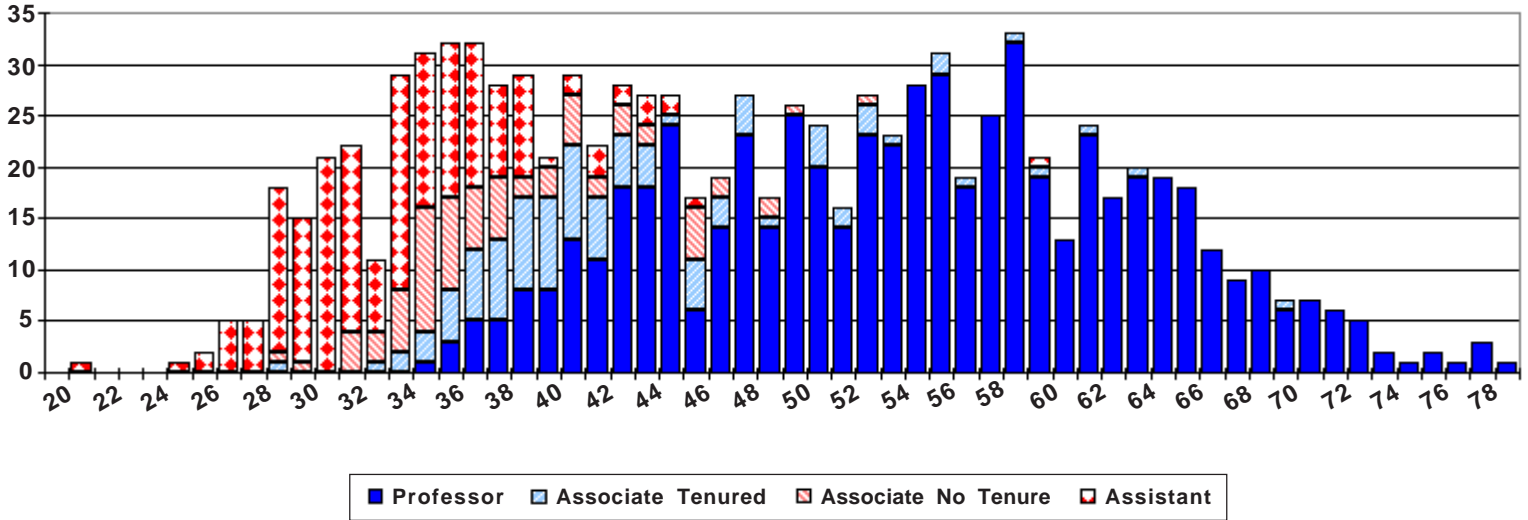
Percent who said "to a considerable extent" or "to a very great extent"



Source: Office of the Provost

M.I.T. Numbers

Distribution of Faculty by Age October 2002



Major Title	<u>21-30</u>	<u>31-40</u>	<u>41-50</u>	<u>51-60</u>	<u>61-70</u>	<u>71-79</u>	<u>Total</u>
Professor	0	30	166	230	146	28	600
Associate Tenure	1	44	38	15	3	0	101
Associate No Tenure	2	51	22	1	0	0	76
Assistant	44	131	13	1	0	0	189
Total	47	256	239	247	149	28	966

Source: Office of the Provost