The MIT Faculty Newsletter

Vol. VI No. 2 **November 1993**

Sustaining Leadership (Part II)

Jay W. Forrester

At the request of the *Newsletter* Editorial Board and the managing editor, this article, the first half of which appeared last month, has been revised and updated from my "Growth, Equilibrium, and Self-Renewal" that appeared in *Creative Renewal in a Time of Crisis: Report of the Commission on MIT Education*, November 1970.

Part I of these comments, in the last *MIT Faculty Newsletter*, argued that MIT is being overtaken by organizations, both academic and commercial, that have followed paths that MIT originally pioneered. Is MIT to continue as a leader into new intellectual areas, or, will it be satisfied merely to compete among equals?

Present MIT policies, which overcommit money, space, and people, operate to suppress innovations that could lay foundations for future greatness. Identifying and cultivating breakthroughs for the next several decades can best be done by maintaining excess human and financial resources. Such excess resources cannot be achieved by seeking more funding. Instead, undercommittment will result only from aggressively discontinuing activities that are past their leadership stage and that other institutions are capable of sustaining. The slack created by withdrawing from aging activities can then be reallocated to nurturing the early stages of ideas that promise future uniqueness for MIT.

The May, 1993, editorial in *The MIT Faculty Newsletter* suggested that MIT is following in the footsteps of failing corporations in which "management burgeoned and became ever more structured." Aging organizations develop a top-heavy management structure. Look at MIT. In 1956 the ratio of full professors to the sum of assistant plus associate professors was 0.5 while in 1993 the ratio had risen to 1.5, a disturbingly large shift toward senior people. Such a change in structure occurs when growth slows and promotions continue as a result of individual longevity. Also, over the last several decades, the fraction of people in administration has risen

(Continued on page 10)

Editorial

Interesting Times

"Denial of the handwriting on the wall avoids the trauma of taking difficult actions. Is MIT denying symptoms of long-term difficulty by reacting only to current pressures? If so, there certainly will be greater crises in the future."

In the present issue of this *Newsletter*, Jay W. Forrester uses these words to conclude the second part of his two-part article responding, in part, to our May 1993 editorial entitled "GM, IBM, MIT: Our Turn Now?"

In the latter, we took note of the internal tendencies toward arrogance and complacency that commonly portend the decline into mediocrity of once-preeminent organizations. It prescribed, in our case, the need for a realistic vision of a vigorous and healthy future for the Institute and the development and implementation of effective new strategies for realizing it. In this connection, it was further observed that some major changes in the way the Institute is organized and governed would probably be required to preserve its leadership position in a rapidly changing world.

(Continued on Page 3)

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Contents

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Editorial

Interesting Times

(Continued from Page 1)

As Professor Forrester noted at the beginning of the first part of his article (*FNL*, October, 1993) the problem of "sustaining leadership" has long been a subject of discussion at MIT, but there has been a paucity of creative responses on the part of the MIT administration.

"An organization can create its future, [notes Forrester] or it can wait to be overtaken by a future arriving from elsewhere." Observing further that "Creating a future requires work, open mindedness and sustained effort," Forrester envisages the creation of "a single ordered list of every activity in MIT according to its perceived contribution to MIT strength and leadership 30 years hence." While we recognize that the "single ordered list" is a striking idea, we believe the interconnection between activities at the Institute are too complex to be so represented. Nonetheless, we must still find a mechanism for maximizing our opportunity for growth. Forrester proposes that because "MIT has no mechanism for...evaluating relative future potential of various activities on an Institute-wide basis," there be established

"a permanent faculty 'Committee for the Future' that would maintain a continuous debate about where MIT should be going in the next several decades ..."

Many decisions affecting the future of Institute programs and the quality of life at MIT — including those on Forrester's list of "academic subjects, research projects, tuition grants to students, dormitories, tuition level, libraries, student body composition, new buildings, administrative functions, eating places, everything" — have been made by the MIT administration with little or no significant input from the faculty. On the academic front, departments are being asked to "downsize," i.e., accept cuts far greater than the average 5%. Still others are being asked to consider mergers. Clearly, steps like these must be made if the Institute is to remain healthy. But the choice of where to cut and with whom to merge has been made by the administration with remarkably little faculty input.

The food services have been "privatized," the faculty club has vanished, many shops have been "closed down," secretarial and janitorial support services have been and are being "cut back," funding for various academic and extra-curricular programs has been and is being "terminated." Important decisions are being made about the relative value of various perquisites and benefits that MIT faculty and staff members currently enjoy.

Other prospective issues currently under administrative review or likely to be considered in connection with current efforts at fiscal "retrenchment" include the future of the MIT Health Services, the Faculty and Staff Retirement Program, and the cost of on-campus parking. With or without our involvement, decisions regarding these and other important issues will be made. It is up to us to decide whether the MIT faculty will play a significant role in the decision process.

We have noted in past editorials and several articles that the MIT faculty has been infantilized. There are occasional faculty tantrums when the provocations are too blatant, but the faculty does not take an active role in formulating policy and playing a role in its implementation. The *Faculty Newsletter* was founded in the hope that it would serve as a forum for discussion of issues important to the faculty and that discussion might have consequences. We think we have had a mixed success; although the *Newsletter* seems to be very widely read, the number of contributors is a very small subset of the faculty. Something more carefully structured to represent the voice of the faculty is needed.

We believe the time has come to institute a "Committee for the Future" of the sort suggested by Professor Forrester. In order to promote more broadly representative faculty involvement and as a way of ensuring the creation of a faculty "Committee for the Future" that is genuinely accountable to MIT faculty, we believe that committee members should be democratically elected to serve for terms of stipulated duration. There is implied in this call an implication that the current faculty officers are not broadly representative of the faculty. That implication is intentional.

This editorial was discussed at a recent meeting of the *Faculty Newsletter* Editorial Board. This is extraordinary procedure, because editorials are usually the responsibility only of the subset of the Board forming the Editorial Committee for each issue, but these are extraordinary times. We considered introducing a resolution at the next faculty meeting calling for the formation of a broadly elected "Committee for the Future," but we concluded that such direct action would be inappropriate in view of our mission of providing a forum, not acting as faculty representative. The *Faculty Newsletter* Editorial Board is still, unhappily, not broadly characteristic of the MIT faculty, although its contributors more accurately reflect its breadth. We then considered providing the text of a sample resolution, urging our colleagues to serve as sponsors for such a resolution. In the end, we decided that we were not quite ready to take even this step without wider participation and a clear mandate.

In the end, we agreed on this. The MIT faculty has very little power to influence the intellectual and administrative structure of the Institute, far less than the faculty at most other institutions; the little power that the faculty has is carefully metered by the administration; that the coming decade will be as perilous and promising an era as the Institute has yet encountered and that the highest level of communal effort is required if we are to meet our highest potential; the faculty must play a real role in the governance of the Institute.

We urge our colleagues to claim the power necessary to help us shape our future. Such power can never be a gift, but must be earned. The alternative is to adapt to the environment that is handed down to us. In that event, we will deserve little sympathy for the plaint that "the administration doesn't understand our needs" or "the Institute is no fun anymore."

Editorial Committee

Missed Opportunities Or False Direction?: Resolving MIT's Fiscal Crisis

Ernst G. Frankel

We have recently been inundated with pronouncements of concern about the Institute's finances, and more recently with proposals on how to resolve these problems and bring the Institute's budget back in line. All proprosed resolutions address the deficit problem by cutting costs, which in turn is to be achieved by reducing employment (nearly across the board) of faculty, researchers, and support personnel — as opposed to improving efficiency, performance, or productivity.

Somehow this reminds me of the attempts by U.S. manufacturers to improve their profitability in the early eighties; trying to improve financial performance by reducing costs by cutting production workers and productive investments, while leaving management and other overhead costs intact. The result was a fiasco, as output fell, unit costs soared, and competitiveness disintegrated.

In more recent years, many U.S. manufacturers have become mean and lean total quality management (TQM) organizations, with a principal emphasis on output and productivity. Much of this was discussed by a group of 70 or so MIT faculty and administrators at a TQM retreat at the IBM Palisades, just over a year ago; yet little has happened to apply the lessons learned and, although IBM has radically changed direction and is putting all its emphasis on becoming a lean, world-class, competitive, flexible, nimble organization with primary emphasis on high productivity, customer orientation, low overhead, and technological innovation, MIT somewhat belatedly tries to adjust to changing conditions by cutting "labor" costs across the board, without regard to output, productivity, or the needs of the customer.

I do not want to address here the issue of the proposed cost cutting, which at best appears ill conceived and imbalanced, but rather to offer another side of the coin which appears to have been ignored altogether – that is revenue enhancing, particularly in the area of education. When an organization experiences losses in sales, it does not automatically cut direct costs, but tries to find new markets and cut indirect costs, which usually imply better use of its facilities and support resources.

MIT has made some rather basic attempts to replace some federal research funding with industrial research funding, and has been reasonably successful in some respects in that area. Yet where it has failed, is in increasing revenues from education and related services, in cutting overhead, and in making better use of its facilities and resources.

MIT's summer programs and other continuing education offerings pale besides those of other institutions. I have offered a well-attended week-long summer course every year for some time which generates revenues of about $100,000/week. Yet the total number of summer course offerings is small and total revenues from these courses is probably in the millions instead of the tens of millions.

MIT's summer programs and other continuing education offerings pale besides those of other institutions. I have offered a well-attended week-long summer course every year for some time which generates revenues of about $100,000/week. Yet the total number of summer course offerings is small and total revenues from these courses is probably in the millions instead of the tens of millions.

Incentives – and particularly recognition of faculty involved in these types of activities – is not only non-existent, but outright negative. As a result, I offer short courses at other institutions (as do other faculty, I'm sure) – in Singapore, Australia, and elsewhere, where rewards and support are very much better.

I was among the first U.S. faculty to offer courses in Singapore and suggested MIT involvement – to no avail. Stanford is now running several

(Continued on Page 14)

From The Faculty Chair

Study Break

Robert L. Jaffe

The chair of the faculty has many social obligations. Most of them are enjoyable, but the one described below was a particular pleasure.

A few weeks ago I received a phone call from "Will" (I have changed the names and deliberately scrambled some of the details of the stories I was told), a representative of the Class of '96, to invite me to the first "Class of 1996 Study Break" from 8:30 until 10:30 the next night. My calendar was empty and my family was willing to do without me for another evening, so I agreed. I had no idea what to expect.

What I found the next evening was an enthusiastic and engaging collection of MIT sophomores, seeking diversion and free pizza in a large, crowded and noisy room on the fourth floor of Stratton. They were eager to talk with each other and with the several faculty members who stopped by as the evening went on.

I believe I spoke with two dozen students in the course of the two hours. They told stories of how they made it to MIT; what they thought of 6.001, 18.02, 8.01X or 5.60; how they had chosen a major; or what they were doing for UROP. These are traditional MIT folktales, however these were not the students one would have seen at MIT twenty or thirty years ago. Most with whom I spoke were African, African-American, or women. I would guess that more than a hundred students appeared at one time or another during the evening and many were from those groups. Frankly, I was pleasantly surprised both by the diversity of the crowd and by their nearly universal good spirits.

It was a seminar in diversity. Sara, an African-American from Houston, described her arrival at a small electronics firm north of San Francisco for a summer job sponsored by MIT's Office of Minority Education, how she'd never before been so close to a horse or so cold in July, how it had confirmed her decision to major in EECS and how she was continuing her summer project through a UROP this semester. Dan, also black, had come to MIT after five years in the army and one at a community college in Oakland. MIT subjects have not been easy for him. Still, he was excited about being a chemical engineer and being at MIT. He could have chosen a less challenging school, but he said he preferred to work hard and get the best. Lisa, from Manhattan, had decided to major in political science and gave a spirited defense of MIT's technologically flavored version of the field. A native Nigerian and another Course VI major, Yusuf had spent last summer immersed in UROP, earning money to support himself in the U.S.

What surprised me about this group was the clarity of their sense that they belonged here. They were enjoying themselves and they intended to make the Institute work for them. A lot has been said about the marginalization of minorities at MIT, about how hard it is for many to make contact with faculty, to find UROPs, to gain a sense of centrality at the Institute, to feel that this is their place. Much of this is certainly true. The incident at PBE last spring focused the MIT community's attention not only on the racism behind the taunts, but also on the frustrations of many black students, who seemed to have difficulty asserting their central place here at the Institute. I suppose I had expected this sense of peripheralization and victimization to hover over my conversations with minority students at the "study break" and was quite surprised when it did not.

Perhaps I met a biased sample — perhaps only "happy campers" showed up that night or dared speak with one of the few faculty members present. I doubt it though, since I made a point of talking to anyone within earshot. Instead, I suspect that these same students caught on a different night, under different circumstances, speaking with someone else, might feel at liberty to relate the incidents which have alienated them from the Institute, its faculty and its culture. Quite likely, both pictures truly represent the experience of being a minority student here.

Perhaps, in retrospect, these conversations took the direction they did because I broke the ice by asking in what department they had chosen to major. Choosing a major is one of the most liberating, upbeat points in an MIT career. With that start, I suspect I tapped into an optimistic and creative vein which brought out the best in their relationship to the Institute.

As faculty, we can make an important, positive impact on students in many ways: not only by virtue of teaching excellently or supervising UROPs responsibly, but also, apparently, when we meet with students informally, by drawing out and validating their own positive version of their MIT saga. Telling stories is one of the important ways we shape images of our selves and interpret our experiences. Faculty should not underestimate the importance of listening to these stories intelligently and sympathetically.

A final comment: it's usually quite difficult for students to get faculty to come to their functions. In this particular case, twelve were invited, five said they'd come, four showed up, and one sent regrets. Not a great turnout, but I've heard far worse tales of faculty no-shows at student functions. If asked, I would urge you to go. I suspect you will come away impressed with our students and optimistic about the growing diversity of our community.

Supporting UROP in the 1990's

Norma G. McGavern

"UROP Costs Could Double Next Year" read a headline in *The Tech* on September 24th. Just days before, a letter from Provost Mark Wrighton about changes affecting UROP appeared in faculty mailboxes. It is true, UROP costs *could* double in the next fiscal year, and the resulting impact on UROP *could* be dramatic.

Some recent history explains what is at stake. UROP undergraduates have been able to choose pay (instead of credit) since 1973, the first year UROP was able to waive overhead costs on wages from sponsored research. In the 1984-85 academic year the number of paid UROPs for the first time exceeded the number of UROPs done for academic credit. Ever since, the proportion of students working for pay has been increasing.

Last year UROP participation grew by 10%, the biggest percentage growth in eight years. Most of this growth was in the number of students working for pay. Summer, a time when credit is an unlikely and expensive option, showed the same upward trend. Today we have as many as 80% of the nearly 2,500 students who work during the term earning stipends. Most of those stipends come from the faculty's sponsored research funds on which UROP has waived both overhead for indirect costs and employee benefits. The rest of the stipends have come from our own budget ("direct UROP funds") and have also been free of overhead and employee benefit charges.

When the U. S. Office of Management and Budget approved Circular A-21 in July 1993 it revised the structure of indirect costs and employee benefits. The effect on graduate students was described in last month's *Faculty Newsletter (*Weinberg, in *Vol. VI, No. 1)*. In the coming fiscal year (1995) UROP will no longer be able to waive overhead or employee benefits on undergraduate research stipends. (From fiscal year 1998 on, employee benefits will not be charged to student wages of any kind.) We will have to find ways to live with these changes.

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Based on this year's rates, UROP's exemption from overhead and employee benefits charges has saved faculty from being assessed more than double what students have been paid. (Overhead is currently assessed at 58% and employee benefits 43%.) A student who may have been paid $1,000 received $1,000; the UROP account (or faculty supervisor's account) was charged $1,000 — total. This has been an extraordinary benefit to students doing research. It has allowed students to earn approximately $5 million in fiscal year 1993 from our own budget (UROP "direct funds") and faculty research funds, combined. For students receiving financial aid, these UROP wages amounted to 15% of total expected self-help earnings.

Even $5 million has never gone far enough. As the UROP administrator with whom most faculty have negotiated for student stipends, Claude Poux, can testify, the ceiling on demand for research support has not yet been sighted, much less reached. Each year UROP's notice that funds are running out appears on our bulletin boards a little bit earlier. Each year negotiations with faculty who would like to have four UROP students, but will have to settle for three or two, get harder. Each year we notice how quickly faculty new to MIT sign up for UROP students. (This probably helps account for the 60% faculty involvement overall.) The steady pressures are especially strong when tuition is increased, the designated self-help level rises, and, to keep pace, we ourselves increase the minimum hourly rate at which students are paid. Next year, in order to earn $5 million, students may need to be granted $10 million. Where will this money come from?

There are some who feel that credit should be the term-time choice for UROP work and pay should be reserved for summer. But the majority (53%) of UROP students who responded to our

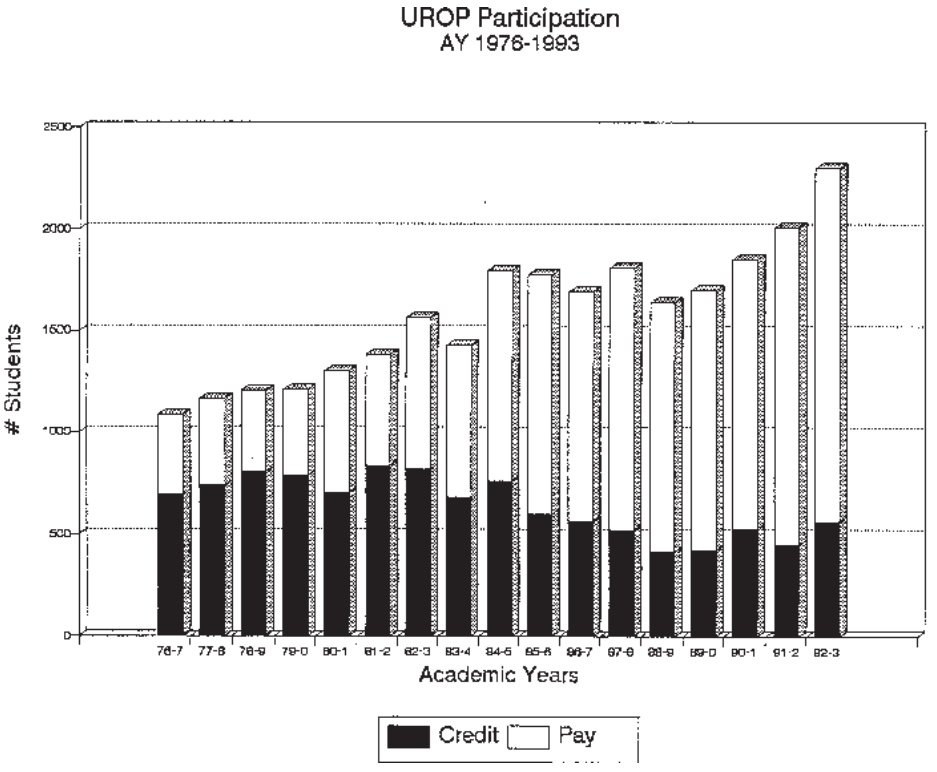
(Continued on next page)

Supporting UROP in the 1990's

(McGavern, from preceding page)

survey last spring said that if pay had not been available during the term, they would not have done the UROP. Perhaps that represents a shortsighted view; MIT students are pragmatic. Nonetheless, there is no evidence to support an increase in the desire for term-time credit. A large number of students have no need for additional elective credit and freshmen face a credit limit.

If we assume the recent trend for paid UROPs to continue, the most likely short-term result may be a smaller UROP program. The first signs of this could be evident soon. Barring an immediate windfall of grants and gifts, a last minute exemption from A-21 guidelines, an alternative to categorizing UROP stipends as "sponsored research," or a substantial budget increase, we will lower the number of spring term proposals funded by about one-third. It is necessary to cut down on some paid spring UROPs in order to keep summer at a steady level. During the term students do have the option of working for credit, like it or not. Students also volunteer in the spring, their motivation being to gain preparation for summer in any way they can. Most students count on summer as the best time to get more deeply and intensely involved in their research. Evaluations of students' work tell us many times over just how deep, intense, and important summer UROP is. UROPers also count heavily on summer earnings. Summer credit is an unattractive and expensive option. In the 1994 summer we expect to feel strain on the resources available. Support will need to be 60% higher than last year (not 100%, because only two months of summer fall in the new fiscal year when the regulations take effect). Savings made in the coming spring term will help us tide students and faculty over during this transitional period.



Next year will be UROP's 25th anniversary year. What kind of year will it be? If overhead and employee benefits cut into UROP direct funding of student stipends – our own UROP funds – it will be difficult for us to support anything close to an equitable distribution of UROPers in areas that lack research support of their own. In other areas where the availability of sponsored research money has allowed participation to be high the numbers may merely be down — perhaps by as much as one-third to one-half. It will be an even more difficult year for freshmen to join UROP. (The first semester is neither a popular nor sensible time for most freshmen to begin a UROP; freshmen who feel ready to take on a UROP tend to begin in January or later in the spring.) Unless the credit limit is raised, freshmen will find it increasingly hard to get involved in UROP. Faculty, who will pay more heavily for UROPers and may feel obliged to make a choice, may choose to pay the more experienced students. This would leave freshmen with little option but to volunteer.

Freshmen generally feel they have few or no skills to bring to UROP work. Our January UROP Mentors Program, begun in IAP 1993, exists to get beginners over that lack-of-skill threshold by pairing them with experienced UROPers. Last year almost every pre-UROPer in the program was invited to join the project in which he or she was mentored. This was a reflection, we think, of how much this training was valued by the faculty who took on these students. Mentors (experienced UROPers) were given a $100 honorarium for their

(Continued on next page)

Supporting UROP in the 1990's

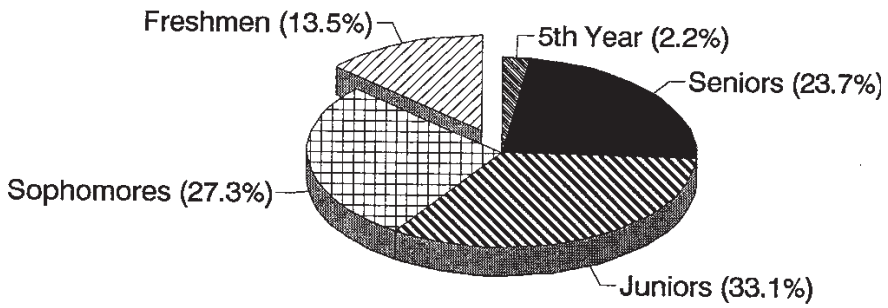
(McGavern, from preceding page)

teaching efforts. What they chiefly learned from the experience was how exacting a task it is to explain what you know to others. Next year, if we have to cut support of fall UROPs because of the additional burden of overhead and employee benefits on our own stipend funds, it will be a challenge to continue and expand the Mentor Program.

To add to UROP's ability to support students, and to make closer ties between the corporate world and undergraduates, the Industrial Liaison Program and UROP have been exploring a "UROP Corporate Fellows Program" whereby, for a yearly fee, companies would directly employ experienced UROP students working with selected faculty in research areas suggested by the companies. The yearly fee would help faculty with materials and services, pay student stipends, and help create additional UROP projects. The new overhead and employee benefit costs could weigh down this effort as well.

UROP's 25th year will be a time for other changes. A positive move in the view of many faculty will be a UROP student's ability to register UROP work done for pay or on an official volunteer basis. This means that UROP will begin to appear on student transcripts as an academic activity. UROP "credit" will be designated without credit units (called URN). At a time when so many students choose pay – a preference that may continue even though the pay becomes harder to get – it could become easy to think of UROP as simply another "job" program. Registering a UROP underscores its academic purpose.

Participation By Class Year (Academic Year 1992-93)



Yet more change awaits. With the beginning of fiscal year 1998, as mentioned above, no student wages will bear the cost of employee benefits, although they will still carry overhead charges which we will be unable to waive. By the time this modification is made, either faculty and students will have adjusted to less available financial support, or UROP will be on a new footing, perhaps with new funds. What UROP looks like in fiscal year 1998 may depend upon what happens in fiscal year 1995.

What many of us hope MIT will eventually achieve is a full endowment for the program. As an activity so close to the heart of what MIT is about, it seems fitting that it find permanent support. In the spirit of UROP founder Margaret MacVicar, the late dean for undergraduate education, we should not hope for less. A flow of regular gifts of small amounts of $10 or $25 from brand new graduates who were UROPers is a testament to the important role UROP has played in their academic lives at MIT. More parents have given gifts designated "UROP" so far this year, according to the *MIT Parents Fund Progress Report*, than they gave to any other specific effort. Obviously, supporting UROP in the 1990's and beyond in the manner to which we have been growing accustomed will take more than this.

At this writing, much is still unclear and to-be-decided. What is known, however, is that efforts are underway to find out some creative way of preserving our UROP budget that comes from special fund accounts and General Funds. If at least UROP's own stipend support were to remain free of additional charges, we would be able to continue to support students working in areas where they have no hope of receiving sponsored research support, and we could continue to supplement some faculty-paid UROP wages.

How we can help faculty with the swollen cost of undergraduate research in general is a question to which we have no certain answer. It may be possible to support UROP students under some conditions by using discretionary (fund account) resources which fall into the category of a gift. In any scenario, however, there will have to be more money for UROP. Fund raising for UROP is now at the strategy stage. It will need to become a priority.

The Value of UROP: An Undergraduate's Perspective

Heather E. Wages

I stood outside the professor's office early that morning, unsure of whether I should knock, wait to be called, or speak with the secretary down the hall. I hung around the door, reading and rereading the notices advertising available jobs and upcoming seminars while listening intently for some noise from within that might suggest an answer to me. After five minutes of fidgeting and trying to appear confident and knowledgeable before the passing students, I screwed up my courage and knocked. Almost immediately, I was called into the office.

I hadn't exactly searched out this UROP; it had fallen into my lap after the professor overheard me debating whether to major in chemistry or biology. He suggested I get into a lab and try them out to see which I preferred. I laughed, because who would want to hire a freshman with no lab experience? He would, obviously, because here I was now, meeting with him and a possible grad student supervisor. I was shaking a bit as I tried to appear cool and collected, calmly discussing what path we would like to see my UROP take. I had no idea what they were talking about when they suggested various projects, so I just agreed to whatever they offered; apparently, they were impressed by this, which they took to be great enthusiasm on my part. The professor sent me off with my new supervisor to take a look around the lab, and give us a chance to figure out whether or not we could work together for the next few months.

For my part, after just a few minutes talking with my grad student, I was convinced he not only knew everything there was to know about chemistry, but could also quite likely walk on water and perform related miracles. The only thing I couldn't understand was why he had volunteered to take on someone as inexperienced as me, when he could have had far more "useful" assistants. I asked him this, and he told me it wasn't important how much I knew, only how much I wanted to know. Well, I certainly wanted to know a lot, and wanted to learn it from this person who seemed to posses unlimited patience to deal with me. It was decided then and there that we wanted to work together on this UROP for the term.

Eighteen months later, I was still working with him. Things had certainly changed over time as I learned how to work in a research laboratory with other people, and how I could make a contribution to the group in my own way. When I began to work in the lab that first term, I was so terrified of making a mistake that might blow up the lab (or at least make me look stupid) that I was unwilling to attempt any work on my own. This lasted only a few weeks, as after that my grad student decided it was time for me to learn a little confidence in myself, whether I wanted to or not. The next time I was ready to begin a synthesis I particularly feared, he was nowhere to be found, and I was forced to go on without him. As furious as I was, I had to admit that I had been able to handle it by myself without a problem, and in fact could probably do most of my daily work without him looking over my shoulder.

My grad student pushed me to be independent in many ways, all of which I found stressful at the time but ultimately rewarding. Early on, I learned that questions rarely brought direct answers. More often I got in return only more questions that guided me to find the answer on my own. I suspected that he just didn't want to take the time to explain the answer to me, but what I see now is that he was expending more effort than if he had simply given me the answer. He taught me how to think in an intelligent way by refusing to do the thinking for me. Later on, when I began teaching chemistry to school children through the volunteer program Magic Show as well as helping my friends with their homework, I found myself using the same techniques I had encountered in the lab. My enjoyment for teaching has increased many-fold since I began to apply what I have learned from my supervisor, and I can even possibly see myself as a professor or lower level teacher some day.

Another thing I learned through my UROP was an increased respect for my colleagues and their time, but unfortunately this part of my education did not come so painlessly. One term I was particularly overextended and overslept a 6 a.m. appointment with my supervisor on three consecutive days. The morning of the third day, he called and woke me up, and all I could do was cry in frustration at having failed again. He let me know just how much I had disappointed him, and I felt so bad I could barely bring myself to slink into lab later that day. I was determined to never fail him again, but I am sure I can't swear that was the case. Both of us were very amused when I found myself using the very same phrases weeks later on a friend who I felt had failed me.

Sharing space didn't necessarily come easily to either my supervisor or me, and there were a few intense debates on proper bench-sharing. I was actually the neater of the two of us, and found it infuriating that I never had clean glassware when I needed. We also had the standard disagreements over what station and how loud the radio should play. I had never worked so closely with someone before, but I feel that I improved my negotiation skills as well as my sense of humor trying to find feasible solutions to our problems.

I think the most important thing I learned as a UROP is confidence in my belief that I belong in a lab and that I can make a significant contribution to a research group through my work. When I began my work, I was certain that a mistake had been made, and that as soon as I was discovered I would be turned out of the group. Each day, though, I learned more about my work and that I was more than capable of any challenge that came my way. My teaching assistants have commented on my high confidence level both in my daily work and in the presentation of my results to the group, and I feel I owe that solely to my time as a UROP.

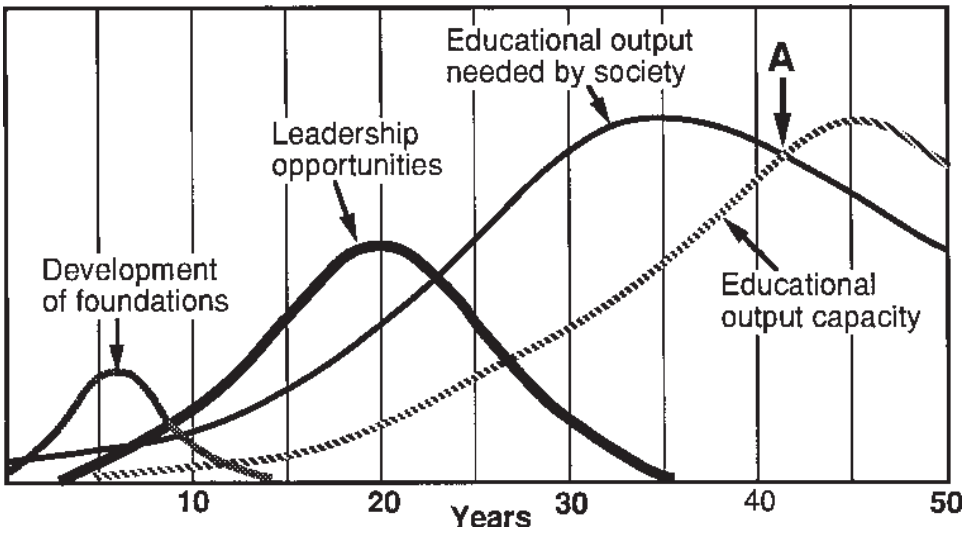
I have learned many valuable techniques and done important research while working on my project, but I feel that the intangibles are at least as important as any published papers that result. Only here at MIT could I have gained such valuable knowledge and experience as I did in my UROP.

Sustaining Leadership (Part II)

(Forrester, from Page 1)

steeply. Such shifts in structure can keep an organization committed to its aging past and prevent redirection toward new opportunities.

MIT has no orderly and sustained process for classifying activities along the life cycle illustrated in the accompanying figure. What programs promise foundations for future leadership? Which are nearing or after Point A and should be discontinued? There is no procedure for continuously updating a list of relative positions of programs in their life cycles so that movement of an activity toward Point A can be anticipated and orderly steps taken for curtailment.



In referring to the figure, bear in mind that the time scale can be expanded or shrunk depending on the nature of a field. A small technical innovation might run its entire life cycle in 10 to 20 years. A new technical field might cover the 50 years as shown. The frontier of technology as a whole might be along a life cycle of 150 years.

Suggesting that MIT focus on the early part of the figure invites the rejoinder that the needs of society cannot be anticipated 30 years in advance. But the decision cannot be avoided. If not made consciously, the decision will be made by default because present day-by-day decisions determine what the Institute becomes in 30 years. There is tremendous momentum in organizations. Today's appointments and allocations of resources will exhibit their major consequences only after a lag of one to four decades.

Without a plan for the long-term future, decisions respond to short-term pressures. Almost without exception, in complex social systems, policies that favor the immediate future are detrimental in the more distant future, and vice versa.

Even starting from the audacious assumption of internal MIT agreement on discontinuing aging activities and actively encouraging new foundations for the future, there remains the daunting task of selecting the old and identifying the new. Here are some suggestions for processes. They are not offered as the only way to accomplish the objectives, and perhaps not the best way. However, an explicit proposal may serve to launch debate and to initiate a search for better ideas.

Discontinuing Old Activities

Maintaining excess resources at all times, so there is freedom to act on new opportunities, requires a sustained process. One should not depend on crisis management or outside forces. The process should be a regular part of every year's promoting, budgeting, and salary adjusting. In the early stages of the figure, new "Development of foundations" and "Leadership opportunities" do not have the political strength to draw their proper resource allocations away from large aging activities lying to the right in the figure. Discontinuation of old activities must be a primary process, not a reactive process. Discontinuation must not depend on new activities pushing out the old. Instead, the vacuum created by eliminating the old will draw in the new.

The proposal here is to annually make and publish a single ordered list of every activity in MIT according to its perceived contribution to MIT strength and leadership 30 years hence. The procedure would create a single ordered list of all activities, even those that would normally be considered incomparable. Everything would be included in one list — academic subjects, research projects, tuition grants to students, dormitories, tuition level, libraries, student body composition, new buildings, administrative functions, eating places, everything. Position on the list would indicate priorities for promotion, salary increases, admissions, budgets, appointments, and termination.

Such a sequencing procedure is possible. When I was head of the largest division in the early days of the Lincoln Laboratory, we maintained such a list on which every staff member of the division, regardless of the kind of work, was placed in sequence. For that limited purpose, the criterion was importance of

(Continued on next page)

Sustaining Leadership (Part II)

(Forrester, from preceding page)

the person to strength of the program five years hence. The list was used for determining salary increases and, at the bottom, as a basis for reducing staff, if required by budget restraints.

The concept of an ordered list is easier to state than to execute. MIT has no mechanism for making such difficult choices. It has no way of evaluating relative future potential of various activities on an Institute-wide basis. Many would say such evaluation is impossible. Most would want to avoid the discomfort, the hard thinking, and the controversy that would come from attempting the ranking. But only if we are willing to do this, can MIT maintain a position of unique leadership and also remain at the relatively constant size that limited financial resources in the next several decades will impose.

The greatest resistance to achieving an ordered list will come from reluctance to try. However, it is irresponsible not to do so. The alternative is to wait until the public judges that a program has already been carried too far. MIT in the last few years has seen the consequences of waiting for outside judgment. MIT stayed with its large military laboratories and budgets until they fell out of step with the times. It has stayed with and pleaded for expanding governmental support of science even after the public sees what scientists have refused to recognize — that science has become inefficient and grown beyond appropriate balance with other parts of society. The harbingers of both these issues have been clear and discussed for at least 20 years. To avoid being caught clinging to the past, MIT must anticipate withdrawing from programs while they are still in good enough health that only insiders can see evidence of ebbing.

Creating the List

Ranking would be on the basis of how an activity is judged to contribute to the strength of the Institute between 10 and 30 years in the future....Such long-term decisions are already made, as in tenure appointments, which often endure for decades. However, tenure is too often granted on the basis of past contribution to aging programs rather than on the future importance of programs.

A ranked list will be created if it must be. It will not be created if there is any chance of escaping the process. As a driving force and discipline, I suggest that money from MIT's own funds, as well as permission to spend external research money, be contingent on a program's appearing on the ranked list. If ranking must be created before expenditure is permitted, then the ranking will be created.

Ranking would be on the basis of how an activity is judged to contribute to the strength of the Institute between 10 and 30 years in the future. A time horizon of several decades is entirely consistent with duration of the careers of students being taught. Such long-term decisions are already made, as in tenure appointments, which often endure for decades. However, tenure is too often granted on the basis of past contribution to aging programs rather than on the future importance of programs.

The criteria for placement on a list should not be refined before the first list is made. A decade could be frittered away discussing criteria, mostly for the purpose of delaying when the issues must be faced. Criteria will evolve. Skill in thinking about the future will improve with practice.

The list will be an approximate guide. Exact ranking cannot be achieved. However, there is little doubt that the programs in the top quarter of such a list will have a substantially different character from those in the lowest quarter. Carrying through the process will itself increase mutual understanding between diverse groups and will cause participants in each program to think through their positions more clearly than would otherwise be necessary.

The comprehensive list would be assembled in stages. Listing would start with subgroups, as within a department; the sublists would be merged at the departmental level (if departments continue to exist); and then the growing lists would be merged for the Institute as a whole.

Because a major objective of creating an ordered list is to identify and protect fledgling innovations, special procedures should be established to prevent local entrenched activities from favoring their positions on the list. For example, the list for a department might be arbitrated by a panel consisting of two members of the department, two from other similar departments, two from very dissimilar

(Continued on next page)

Sustaining Leadership (Part II)

(Forrester, from preceding page)

departments, two visiting committee members (one from a different department), and a member of the Corporation.

Using the List

The list will act as a guide to the future. Those high on the list deserve encouragement. Those declining in ranking would be making plans for discontinuation.

The top half of the list would be favored with expansion, new appointments, tenure promotions, and salary increases. Those in the bottom half would receive no tenure promotions, few if any temporary appointments, and limited salary increases.

Every year, activities in the lowest quarter would be reviewed to pick candidates for discontinuation. Between 5% and 10% of MIT's total activity should be discontinued each year. This is between one and two average-sized academic departments, or the equivalent in smaller pieces. The process should be one of total discontinuation of the entirety of specific activities, not a proportionate budget squeeze applied across the board. Completely cut out both those activities whose promise as "Development of foundations" has faded and those whose "Leadership opportunities" have already succeeded and where there is an established outside source that can carry on.

Presumably, a desirable activity will start high on the list when it is perceived as being a part of the long-range future. As it matures and ages, it will, over a period of 10 to 30 years, as a result of its success, gradually work its way down on the list. An activity will have a forewarning that its end is coming. There should be ample opportunity and incentive for individuals to identify and shift to new areas that are compatible with an innovative mission for MIT. The process would be especially effective for encouraging individuals to find and develop new careers.

Much of the stagnation of an organization reflects that of individual careers, which in turn result from the social structure of the organization itself. By focusing attention on organizational renewal, individuals will be encouraged to consider their own career renewal. People of the kind that MIT should most want can master the frontier of a new field in less than ten years and can aspire to participate in two or three consecutive life cycles from "Development of foundations" through "Leadership opportunities."

Identifying Innovative Opportunities

The greatest challenge for this proposal lies in selecting among ideas that promise a basis for MIT's future strength. Making such choices is subjective. The usual peer-review process is not workable because, in the earliest stages of a new idea, there are no qualified peers. There can be no confidence that any single person or committee can decide wisely on the future prospects for an untested idea. Any person or group with a monopoly on making selections will indulge their own sincerely held prejudices.

Perhaps the best hope lies in competitive channels for endorsing early stages of innovations. There should be at least three alternatives in the Institute. First would be at the departmental level. Second would be an Institute-wide committee charged with the sole duty of reviewing proposals for the more distant future. Third would be a person in the President's office, seeking outside advice, with no other task than to review proposals that had been refused by the first two channels.

At every level of review, the burden of justification should rest with those refusing a proposed innovation, rather than the burden of proof for support resting with the proposer. This is necessary because of the weak bargaining position associated with innovations. The three evaluation channels would be separately competitive. Each would have its own budget to support new ideas. Each would operate under the threat of turning down an idea that another channel might accept and demonstrate to be viable.

Some 10% of the Institute's annual budget should be divided among these three "innovation channels" that have no other role than to find and support activities that are expected to become important several decades in the future.

Creating The Future

An organization can create its future, or it can wait to be overtaken by a future arriving from elsewhere.

Creating a future requires work, open mindedness, and sustained effort. There must be a focal point for such an undertaking. I suggest a permanent faculty "Committee for the Future" that would maintain a continuous debate about where MIT should be going in the next several decades. Members should be selected for demonstrated daring, unconventional thinking, and understanding of the innovation process. The Committee for the Future would present a provocative report to the faculty twice a year. Nothing should be off limits for discussion, for example:

• Does the future lie in technology? Is MIT a captive of its name? There have been a series of frontiers down through history — establishing governments, creating the great literatures, discovering the geography of the earth. The most recent frontier has been science and technology. But frontiers become

(Continued on next page)

Sustaining Leadership (Part II)

(Forrester, from preceding page)

explored and diffuse into everyday activity. Is it time to think about the frontier that follows technology?

• Where are the great problems of society? Do they not arise from the behavior of social, economic, biological, environmental, medical, and governmental systems? Perhaps the challenging frontier for the next hundred years lies in coming to understand and to improve such systems. Such could build on the background of MIT in pioneering methods for dealing with engineering systems. Engineering systems are simple and easy in comparison with the troublesome systems in which we are imbedded, but the methodologies have advanced to where they can cope with the more complex challenges.

• Management schools have been teaching people how to operate corporations. The analogy is a department devoted to training pilots how to fly airplanes. But aeronautics departments do not train pilots, they train people to design airplanes. It is now possible to imagine a school for "enterprise designers" who could create organizations with policies and structures to achieve desired behavior even when staffed by ordinary managerial operators.

• Should the departmental structure of MIT be eliminated? Departments create rigid compartments. True innovations often lie outside of existing departments or overlap two or more departments. The departmental structure does not provide a home for daring innovation. Without depart-ments, people would be much more free to form clusters around new ideas and move to where the future is being created.

I suggest a permanent faculty "Committee for the Future" that would maintain a continuous debate about where MIT should be going in the next several decades. Members should be selected for demonstrated daring, unconventional thinking, and understanding of the innovation process. The Committee for the Future would present a provocative report to the faculty twice a year. Nothing should be off limits for discussion....

The May 1993 editorial in *The MIT Faculty Newsletter* suggested that MIT is following the path that led to the decline of several major corporations. Some symptoms support such an assertion.

The fundamental threat to corporations has come from excess capacity. Detroit automobile companies would still be doing well were it not for a worldwide excess of automobile capacity. Excess airplane seats have led to bankruptcy of airlines. Excess capacity is now emerging in higher education. Under financial pressures arising from capacity beyond what society can support, many schools will retrench or close. Those with the strongest future-oriented programs will survive and prosper.

Many corporations responded to faltering growth in sales by cutting prices rather than by giving primary attention to the underlying weaknesses of low quality, lack of innovative products, and confused objectives. Universities are now engaging in the ultimate price discounting. They are paying (with tuition grants) their customers (students) to take their products (education). One does not remain solvent by buying customers. Is the role of a university to act as middleman by putting great effort into raising funds for redistributing wealth, or is the role to focus on education and research?

When corporations were criticized for low quality products, such allegations were often rejected as merely arising from public misunderstanding, and responsibility for correcting quality problems was turned over to advertising departments. The same thing has sometimes occurred in MIT where the solution to falling public esteem has been seen as a public relations problem rather than as a signal for making fundamental internal change.

All of these corporate weaknesses may arise from a more deep-seated psychological response – the unwillingness to acknowledge evidence of impending problems. Denial of the handwriting on the wall avoids the trauma of taking difficult actions. Is MIT denying symptoms of long-term difficulty by reacting only to current pressures? If so, there certainly will be greater crises in the future.

Missed Opportunities or False Direction?: Resolving MIT's Fiscal Crisis

(Frankel, from Page 4)

one- to three-week courses jointly with the University of Singapore which are estimated to net each summer in excess of a million dollars.

I would suggest that MIT seriously consider expanding its professional education and related activities. This should include:

1. expanded year-round professional course offerings with 2-10 day courses at MIT and various other locations;

2. revenue generating professional conferences at MIT and elsewhere;

3. joint programs with other high-class institutions, particularly abroad, such as the joint program between the Sloan School and Nanjang University in Singapore;

4. executive engineering and technology management programs in the School of Engineering, tailored on the Sloan executive program; and,

5. special engineering management, research, and technology development courses and seminars to help train people in government and industry in the need for defense conversion, productivity improvements, technological advance, and TQM.

I am well aware of the concerns and probable resistance to such developments which some may feel dilute MIT's self-proclaimed mission, but I feel that the time has come for us not only to proclaim our concerns about U.S. competitiveness, but to do something about it. Such activities will not only enhance MIT's revenue stream, but also its reputation as a can-do institute and its contacts with industry and government. But this can only work if the MIT administration recognizes such activities as not just peripheral, and gives full recognition to the faculty and researchers who actively promote it and offer such new services.

Personally, I will be declining to teach summer courses, ILP seminars, IAP credit courses, freshman advising, CAES, etc. for the first time – after many years – not because I can make many times the money doing the same elsewhere, but because of the complete lack of recognition and incentives given by the Institute.

MIT lags seriously behind other institutions such as Harvard, Stanford, Yale, Chicago, and others in developing such new educational initiatives, and we may miss the boat unless a determined effort is made now.

MIT's Role in Further Education

Some experts estimate that a professional degree will help one in good stead for only a short number of years. *The Economist*, for example, has estimated that an MBA is good on average for eight years. Engineering degrees, in some areas, have an even shorter value before reaching a state of increasing obsolescence. Knowing how to learn and continuously updating knowledge is the key qualification today for most professional jobs in this knowledge age.

MIT must become a meaningful contributor to this process – necessary to maintain not only **our** technological position, but our nation's as well. Indeed this process of learning and updating knowledge may indeed become a prerequisite for continued intellectual and scientific leadership. MIT, like other institutions of higher "learning," will have to rework its approach to education and promote instead one which encourages continuous learning, to assure not only the maintenance of technological knowledge of professionals outside the Institute, but also within. Collaborative learning and knowledge feedback is today essential for the advancement of technology and the maintenance of MIT's role of technological leadership.

Continuing, high level, educational programs are an integral part of education in technology and science today, as well as in management. Unless we assume a determined role in this field, our influence in shaping the future and our technological leadership may be at risk.

MIT uses its major educational facilities and resources less than eight months per year. Extended educational programs could be introduced, therefore, with very small overhead costs.

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The next issue of the *Faculty Newsletter* will appear during IAP. We hope to have faculty response to issues raised in the current *Newsletter*, including the MIT fiscal crisis, UROP, etc.

We encourage submissions on these or any topic of interest to the MIT community. Information on reaching us can be found on Page 2.

Letters

To The Faculty Newsletter:

The administration's self-examination seems to have fully exonerated them of any responsibility for the current deficit – no reason has been found to reduce their staff, limit their growth, nor is any need seen for an independent inquiry. And what more convincing justification for bad procedure can there be, than to have the unquestioning, loyal endorsement of the departing faculty chair? (In this *Newsletter*, May 1993.)

But *Faculty Chair* is somewhat of a misnomer. In practice and by design, that office has represented the administration to the faculty; it has never really functioned as the advocate of faculty interests. Although the faculty chair is supposedly an elected position, there is always just one candidate who has been culled through a sieve of committee service and certified thereby to be safe to the administration in thought and deed. However, this position could be the key to substantial reform by the following actions of the faculty.

1. Elect a candidate to be chair who will truly represent the faculty in a positive and forceful manner. The faculty rules make it relatively easy to have a genuine election.

2. At the first faculty meeting thereafter, strip the voting rights accorded to non-faculty administrators (who pack the thinly attended sessions).

3. Pass a resolution to the effect that all administrative appointments equivalent (in salary) to the rank of assistant or associate professor shall be reviewed by an *ad hoc* faculty committee to determine the necessity of the position and the quality of the candidate. Making the administration live by the same rules as the faculty will bring unbridled and unnecessary growth to a halt.

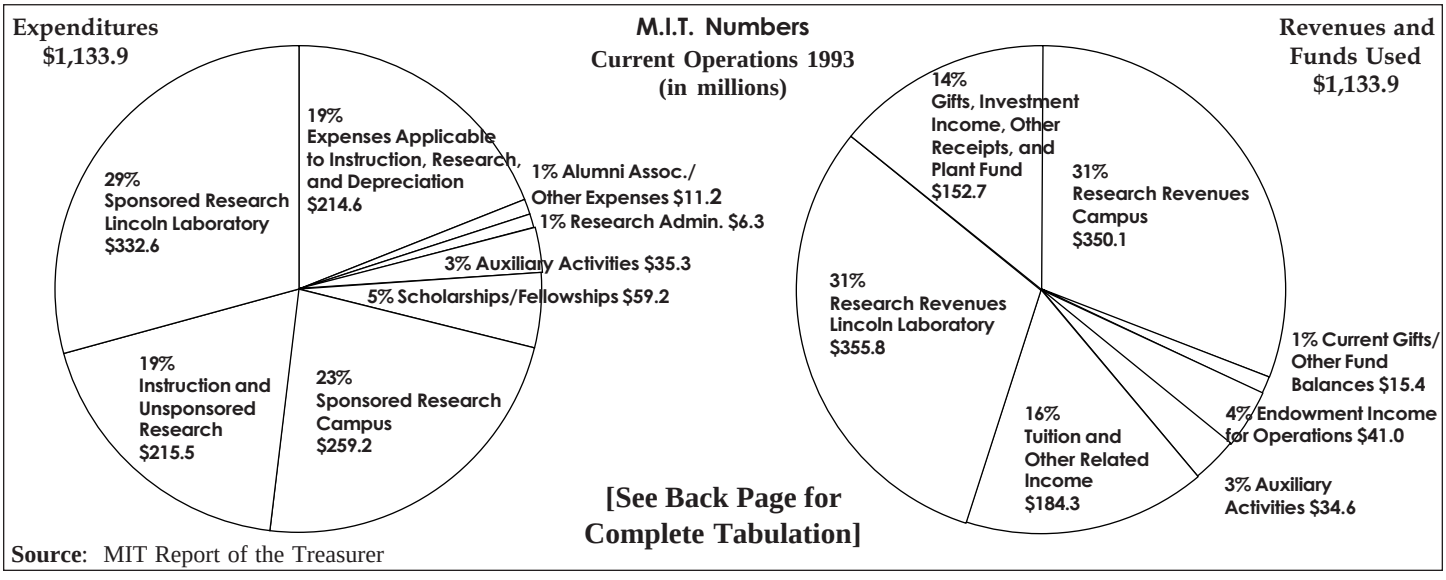
4. Consider the elimination of faculty tenure for senior administrators after a reasonable but short period of service. Tenure can be reconsidered upon return to faculty status, but by the same criteria as other appointments, and at the appropriate salary levels. This would block a number of overpaid administrators from their overpaid retirement sinecures and allow the resources and positions to be better used to appoint younger researchers who can contribute positively to the reputation of MIT. The rewards of high office should not be risk free. (The practice of administrators having themselves made Institute Professors, too often an honor without merit, can also be ended if only in the interests of fiscal responsibility.)

5. Appoint a committee to review all factors of the present financial predicament, including any real estate and business adventures that may have become liabilities.

6. Continue to press for a vastly reduced bureaucracy before new limits of any kind can be imposed on the faculty.

Faculty, students, and alumni are MIT, a fact mostly ignored by officialdom except for occasional, obligatory platitudes at commence-ment, and in announcements of policy decisions that call for sacrifice, meaning faculty sacrifice. Perhaps the steps above will correct the arrogance evident in those empowered mainly by default. At the very least, these actions are one painless step away from economic crisis and toward a healthier community.

Harvey P. Greenspan
Professor of Mathematics



Source: MIT Report of the Treasurer

M.I.T. Numbers

Statement of Revenues and Funds

For the Year Ended June 30, 1993

(*in thousands of dollars*)

	Total 1992	**Total 1993**	Unrestricted	Institute or Donor Restricted
OPERATING EXPENSES:				
Instruction and unsponsored research	$ 206,987	**$ 215,540**	$121,069	$ 94,471
Sponsored research:				
Departmental and interdepartmental	231,503	**259,208**	--	259,208
Lincoln Laborator	342,136	**332,579**	--	332,579
Research administration and general expense	3,967	**6,246**	6,246	--
Expenses jointly applicable to instruction and research:				
Libraries	12,895	**13,198**	12,361	837
Medical	9,435	**8,337**	8,337	--
Plant operation and maintenance	61,316	**69,913**	62,764	7,149
Administration	22,291	**23,263**	20,113	3,150
Fiscal, personnel, and other Institute-wide services	37,420	**37,418**	36,892	526
General expenses	22,788	**25,894**	19,120	6,774
Other instruction and research support activities	6,900	**7,404**	5,948	1,456
Student services	16,943	**20,114**	15,550	4,564
Alumni Association	6,512	**6,827**	6,827	--
Other expenses	2,261	**4,410**	179	4,231
Scholarships and fellowships – Undergraduate	28,981	**32,545**	16,015	16,530
Scholarships and fellowships – Graduate	29,781	**26,653**	3,538	23,115
Dining and Housing	18,456	**19,132**	720	18,412
MIT Press	15,609	**16,159**	--	16,159
Operating expenses before capitalization of equipment	1,076,181	**1,124,840**	335,679	789,161
Less: capitalization of equipment included above	(15,385)	**(16,704)**	--	(16,704)
Depreciation of buildings and equipment	22,564	**25,755**	--	25,755
Total operating expenses	**$1,083,360**	**$1,133,891**	**$335,679**	**$798,212**
REVENUES AND FUNDS USED:				
Tuition and other related income	170,301	**184,320**	$184,320	--
Research revenues:				
Departmental and interdepartmental	319,634	**350,106**	90,898	259,208
Lincoln Laboratory	367,377	**355,795**	23,216	332,579
Endowment income applied to operations	38,297	**40,959**	19,455	21,504
Gifts, investment income, and miscellaneous receipts for:				
Scholarships and fellowships	41,481	**39,645**	--	39,645
Other restricted and unrestricted purposes	92,903	**104,012**	2,358	101,654
Plant fund used (additions)	7,179	**9,051**	--	9,051
Dining and Housing	17,488	**18,412**	--	18,412
MIT Press	15,609	**16,159**	--	16,159
Gifts and fund balances used to meet operating expenses	13,091	**15,432**	15,432	--
Total revenues and funds used	**$1,083,360**	**$1,133,891**	**$335,679**	**$798,212**

Source: *MIT Report of the Treasurer* (Schedule A)