The MIT Faculty Newsletter

Vol. XII No. 1 September/October 1999

Engineering Systems Division

ESD Created to Broaden Engineering Education

Daniel Roos

*In December 1998, the School of Engineering established a second new division, the **Engineering Systems Division (ESD),** which focuses on the engineering of complex systems. The creation of ESD responds to a need for the development of new approaches, frameworks, and theories to better understand engineering systems behavior and design, as well as a need within the School for the development and support of educational programs on complex systems and design synthesis that will prepare students for leadership positions. ESD is an integrative effort that cuts across the School of Engineering departments. In addition to the engineering departments, ESD works with the Sloan School of Management, the School of Humanities and Social Sciences, and the School of Architecture and Planning to develop an integrative approach to engineering systems problems. Overall, the Division provides an institutional framework*

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Proposal to Change the P/NR Grading System

Travis Merritt and Arthur Steinberg

Need for Change

From informal discussions among colleagues who teach in the freshman year, we have concluded that there is uniform discontent over the second semester of grading on the pass/no record system. We have therefore undertaken to propose a change to this system, and hope that it may come before the full faculty before long for discussion and vote.

Pass/NoRecord was instituted for:

- Facilitating the transition to MIT for students with widely varied preparation;
- Accustoming students to a new pace of learning at which MIT subjects are taught, and accustoming them also to the expectations of a very demanding faculty who all have professions as researchers and proposal-writers;
- Accustoming students to taking mostly science core subjects, rather than a wide range of different subjects; and taking subjects which might not be of primary interest to them.

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Some Meditations On Knowing Too Much

John Hildebidle

Lawyers, insurance operatives, poets – none stand high on the list of comic figures. Since Wallace Stevens was all three, with considerable success, you might expect high-flown language or elaborate and incomprehensible word-pictures. During his life he compiled a long assemblage of what he called "Adagia." The ponderous Latin of the title – why not just call it "Observations" – adds to the dread.

Sure enough, the collection contains a number of knotty enigmas. But surprisingly, there are some deft one-liners, as well. One of my favorites – I can never decide which category it best fits – is this: "One's ignorance is one's chief asset." I like to urge my students to commit that one to memory ("a fine aphorism to offer if and when you flunk a mid-term," I always say). But I think there may be a serious applicability to our endeavor here at MIT. And a sort of warning, as well. Not, I hasten to add, that I want the designer of the next bridge I have occasion to cross or airplane I find

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Subscriptions: $15/year On-Campus
$20/year Off-Campus

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Editorial

We Happy Few

The *Faculty Newsletter* was born at a time of crisis, in an attempt to forestall further crises. The precipitating act was the administration's announcement that the Department of Applied Biological Science (ABS) would be eliminated. The decision to terminate the department was not the issue; there were reasonable arguments on both sides. However, the faculty was not involved in the decision, and was unaware that any such action was under consideration. The announcement was not just a reminder to the faculty that the administration was empowered to make such decisions without consultation, but also clear evidence that they would do so when they thought it necessary. The furor lasted for months, and repercussions linger in the form of distrust between faculty and administration.

The ABS dispute pointed out the need for better faculty-administration communication, as well as the need for better intrafaculty discussion of matters of common interest. The *Faculty Newsletter* was instituted to meet these needs, by providing an open forum for introducing and exploring issues of interest to the faculty. In addition to unsolicited contributions from the faculty on any subject thought interesting or amusing to our colleagues, regular commentary in the pages of the *Newsletter* from the chair of the faculty, synopses of committee reports, discussions of proposals to be considered at faculty meetings, and the like, have proven the wisdom of this intent. Although, from its inception, the *Newsletter* solicited input from the administration, it remains an independent entity, run and completely controlled by the faculty.

The *Newsletter* operates with a volunteer Editorial Board and a professional Managing Editor. The Managing Editor is responsible for all aspects of production except for soliciting articles and approving final copy (the responsibility of the Editorial Committee for each issue). We produce and distribute approximately 15,000-17,000 copies of 5-6 issues per year, at a total cost of approximately $80,000 per year. This is more than is available via individual donations (which paid production expenses for the first several issues). Advertising revenue does not seem desirable and would probably be inadequate. Subscription-based delivery would probably double the cost of production. Very early on it was clear that the *Faculty Newsletter* would have to depend upon funding support from the administration. And yet we required a funding arrangement that allowed us to maintain editorial autonomy.

We argued that, similar to parking lots and lunch rooms, the *Faculty Newsletter* provided a service to the faculty which also benefited the administration (and hence the Institute as a whole). To the higher administration's credit, it has always supported this position. The Provost's Office, under Jay Keyser, covered expenses when the *Newsletter* was just starting, and the President's Office, under both Paul Gray and Charles Vest, has strongly supported our efforts ever since.

As of spring 1996, we began operating under a five-year agreement with the President's Office guaranteeing level funding, and endorsing our unique funding mode. The agreement was also endorsed by the Faculty Policy Committee, which agreed with our claim that we, to a substantial degree, responsibly represent the collective interest of the faculty. It is our claim that we represent the faculty that justifies our access to Institute funds. Our responsibility is to use the money responsibly, in the best interest of the institute.

We are vulnerable to criticism because of the volunteer (non-elected) nature of our Editorial Board and its relatively low membership. It has been suggested that the Editorial Board should be selected by the Nominating Committee. We believe, and successfully argued before the Faculty Policy Committee, that an Editorial Board selected by the Nominating Committee would lose credibility as an autonomous entity. The Board could be selected by a vote of the faculty, but a meaningful election would require a great deal of effort on the part of the "candidates" and the complicated mechanics of the voting process. It is much simpler to have a policy in which any faculty member who wishes to join the board may do so. The volunteer nature of Board membership seems to us to be optimally democratic.

We prefer to believe that the low volunteer rate is a reflection of the faculty's satisfaction with the way the *Newsletter* is currently run. But, of course, such a belief is self-serving. We are planning to poll the faculty via e-mail to determine the actual level of interest in, and support for, the *Newsletter*. This information will be

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Walking a Tightrope: Where We Are Now

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useful, but it is not enough. The obvious solution to the criticism that the Editorial Board is too small is to have more volunteers. If you are a member of the faculty, you are, as the credit card ads say, prequalified.

We believe that our unique blend of unappointed editors and no-strings funding is working, and that the *Newsletter* is helping to make the Institute a better and more interesting place.

October 25 is St. Crispin's Day. What better day to join our band? If you think the *Newsletter* is important to the Institute, join us. If you think the *Newsletter* should be doing some things differently, join us.✥

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SAP: Time for an Assessment?

Now that the SAP accounting/ reporting system has rolled out (and indeed a further upgrade is planned [see page 35]) it may be time to assess just how well we have done.

Recent anecdotal information through correspondence with faculty, researchers including graduate students, and support staff has revealed that SAP may have transferred a significant burden from the central administration to individual units. Some SAP users estimate that they are now spending more than twice the amount of time getting approval for and tracking purchase orders, reconciling monthly statements, and printing material that used to be mailed on a regular basis and which is now available only in electronic form. The cost of the printing has also been transferred to the local level without any apparent reduction in overhead charges for what is now a direct cost.

These problems may be exacerbated by the removal of secretarial assistance as individual budget line items from research grants obtained from the National Science Foundation and National Institutes of Health.

Could it be that the promise that SAP would improve life has not been fulfilled? In order further to evaluate the situation, we are inviting commentary through the *Faculty Newsletter* on experiences with SAP. Please talk to your staff and others who use SAP and e-mail us at fnl@mit.edu; (put "SAP" in the subject line). We'll share your comments next issue.✥

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Next Issue

It appears that Reengineering at the Institute has been completed. Yet many questions remain. What was done? How successful was it? How much money was spent/saved? What (if anything) is next? In the next issue of the *Faculty Newsletter* we will attempt to answer these and other questions relating to Reengineering. And we'll have a Q&A with the man who is primarily responsible for much of what goes on around here, Executive Vice President John Curry.✥

Editorial Committee

From The Faculty Chair

More Than Meets the Ear?

Steven R. Lerman

Professor A is preparing for a class that is about to start. This is her first semester teaching at MIT, so she is pulling together a great deal of new material, and is trying to get something photocopied quickly at the department's headquarters. Since she shares a secretary with five other faculty members, she decides to do it herself. She is standing at the photocopying machine, when Professor B, a male senior faculty member in the department, comes by and hands her 10 pages and tells her to, "Please make 20 copies of this for me. I have a class in 20 minutes."

Professor A, who is young and inexperienced, is taken aback. Saying nothing, she accepts the papers. In retrospect, she is angry and upset. Why did this very senior faculty member treat her so inappropriately? And, perhaps more importantly, what sort of place to work is this going to be?

Professor B, when later asked, comments that he was never introduced to Professor A, and that when he encountered her at the photocopying machine, he assumed she was someone on his department's support staff. Professor A was young, female and standing at the photocopier. The support staff people he has known are mostly young and female, and he "naturally assumed she was a secretary."

I confess that this precise situation is a composite of several different reported encounters. Despite the fact that I fictionalized the details, many female faculty members I have spoken with report at least one version of this sort of encounter. From the senior faculty member's viewpoint, the encounter is a harmless case of mistaken identity; its meaning for his younger colleague is far different. She feels undermined and angry, and often will attribute harmful intent. Even when he later apologizes with a remark that he made a mistake that was understandable given the circumstances, she emerges from the encounter feeling diminished in her new role as a faculty member.

Most of us have the experience of talking to two different people who were at the same meeting. As each describes what transpired at the meeting, you wonder whether they were on the same planet, let alone at the same meeting. This is particularly the case when the meeting involved discussions in which both of the participants have strong, emotionally charged initial positions.

An interesting thought experiment is to ask how a young, male faculty member might view the same situation. First of all, the whole incident is far less likely to occur. When I first joined the faculty, I was very young, and I looked more like a student than a professor. Nevertheless, I never experienced an incident such as this one, and to my knowledge neither have my male colleagues. Moreover, the interaction would have had different psychological meaning. I would have interpreted the problem much more as a mismatch in ages than as gender-related. While I might have been somewhat offended, I doubt if I would have felt as deeply hurt as my hypothetical female colleague. In part, this is because I knew that in the long run, I would become part of the mainstream of what was then my department's culture. My hypothetical female counterpart is far less certain of this. The encounter resonates with, and reinforces, a sense of insecurity about how she will be treated in the future.

Most of us have the experience of talking to two different people who were at the same meeting. As each describes what transpired at the meeting, you wonder whether they were on the same planet, let alone at the same meeting. This is particularly the case when the meeting involved discussions in which both of the participants have strong, emotionally charged initial positions. Tenure and salary reviews, disciplinary proceedings and meetings with students about poor grades, all come to mind as situations where such divergence in reports of what happened is commonplace.

In the same way, two people may emerge from encounters such as the

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one I described above with very different interpretations. One person's unintended case of mistaken identity may be a serious, harmful event for the other person. This has consequences for all of us concerned with creating an academic community in which everyone has a sense of belonging.

At a departmental dinner meeting, Professor C, a younger, African-American colleague, is sitting across the table from senior Professor D. The two are in different parts of the department and haven't met before. They are discussing John Smith's new research in the senior colleague's field. The younger faculty member ventures an opinion that this new work may well turn out to be important, not knowing that it has the unfortunate property of contradicting research of his older colleague. Professor D reacts in a way anyone who knows him well could have predicted, by announcing in a loud voice that, "Smith's work is utter and complete nonsense. It is filled with major errors that almost anyone can see."

Professor C takes this as a personal insult. He doesn't know quite what to say at that moment, so he gets up and walks away from the table. Professor D is somewhat bewildered, but assumes that Professor C has another meeting to go to, assuming that otherwise he would have stayed and talked more.

In my imaginary debriefing, Professor C views this encounter as yet another insulting form of racial prejudice. He reasonably assumes that he has been summarily dismissed as a respected colleague, and that Professor D views him as not really meriting the faculty position for which he has worked so hard. Life was difficult enough being the first black faculty member the department ever hired without having Professor C already criticizing him. Others in the department reassure him that Professor C always expresses his views like that, and that it isn't an issue of race, or anything else, but at worst personality conflict.

When asked, my hypothetical Professor D views Professor C as unwilling to participate in the normal give-and-take of an intellectual exchange. He comments that the culture of the department has always been one of being very direct and blunt. "You can't make real breakthroughs in science if everyone tiptoes around trying to be overly polite all the time."

This is one of those interactions where both people bring their unseen, internal baggage to the table. Professor C is reacting to his previous experiences and from a sense of being an outsider by virtue of his race. He may have experienced a number of racially-motivated insults over the years. Professor D did his graduate work at MIT and has been part of his department's culture since he was an undergraduate. He values the custom of speaking frankly without worrying too much about causing offense. From his perspective, he was treating Professor C just like he treats everyone else, and he sees no reason to change his department's culture. In fact, he sees being less direct as insulting to Professor C.

Professor E is at a departmental retreat and takes a seat next to Professor F, one of his female colleagues. He casually asks her how her family is. She curtly replies that her husband and children are all well, and asks him how his research is going.

My hypothetical Professor F comments later that it always seems that her colleagues are asking about her family as though they think her work is unimportant. She is confident that they rarely ask their male colleagues the same question. Professor E, when later asked, says that he often inquires about family life in the work setting because he is truly interested. Moreover, he thinks that separating work and family life isn't all that healthy, particularly when most of us spend a huge amount of time at work.

My examples are all based on the assumption that the involved parties are acting without malice or conscious bias. I know full well that this isn't always the case, but, perhaps naively, I believe that it is usually true. So, with that as preface, here is my own, personal advice to all the parties involved.

To my senior colleagues: The professor who handed his photocopying to a young women and assumed she was a secretary, needs to do something that is simple to say and hard to implement. He has to recognize that even though he is right that most of the support staff personnel are female, the effects of the instances when such assumptions are wrong are serious. Wouldn't it be far simpler not to assume anything about people's positions based on statistically informed guesses? No harm is done by inquiring first by asking a simple question such as, "Have you seen any of the support staff around? I need help with some photocopying."

Professor C, whose blunt style unintentionally offended a new colleague needs to recognize that newcomers may not be clued into the department's culture. Moreover, as

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our faculty becomes increasingly diverse, that culture may need to change. The line between being direct and being rude is hard for many people to discern.

Finally, in my view, Professor E should continue to make family life an accepted topic of conversation as long as he is consistent regardless of his colleagues' gender. In my view, we need more of this around MIT.

To my new colleagues: I won't insult you by trying to convince you that among the nearly 1000 faculty here there aren't some whose actions will be motivated by outright bias. However, I believe that my hypothetical encounters are much more typical. I don't mean to suggest by this that you should ignore such situations; clearly, real harm is done in such encounters independent of the motives involved. I simply urge you to speak with the other parties, starting from the assumption that no malice was intended, and to try to convey a sense of how you were affected by it. Such conversations can be very difficult, but they can make the difference between long-term hostility and healthy, collegial relationships. Not all such discussions will go well. You may discover that there was, in fact, harmful intent. Your senior colleagues may feel unfairly accused and react accordingly. In spite of these risks, remaining silent in such situations contributes nothing towards reducing their frequency.

To all of us: Although I described encounters between two colleagues, there are often observers present as well. Most people's natural reaction in such situations tends to be an embarrassed silence. Despite this tendency, we all have an obligation to work on behalf of the community we want to create. Speak to both individuals involved, making it clear that the conversations may have had unintended, but nevertheless serious, consequences. If you work in a department where frank exchange is highly valued, try to communicate this to the new faculty members so that they are prepared. If you think someone is misinterpreting a well-intentioned question as bias, make sure you say so.

I am certainly not naïve enough to think that all our problems will be solved if everyone follows the above advice. However, MIT would be a better place for all of us if we could manage our collegial relationships better. Stopping situations such as the ones I describe, or at least trying to turn them into productive, learning experiences for everyone involved, can be an important first step.✥

[Steven R. Lerman can be reached at lerman@mit.edu]

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Provost Announces Request for Nominations for Margaret MacVicar Faculty Fellows

The Margaret MacVicar Faculty Fellows Program was established in 1991 to recognize and enhance undergraduate teaching at MIT. This program honors the life and contributions of our late colleague, Margaret MacVicar, who was dean for Undergraduate Education. Any member of the MIT community may submit nominations.

The nomination should be a substantial case. Along with three supporting letters from students, it should include a nominating letter documenting the contributions of the nominee, three supporting letters from faculty, a curriculum vitae of the nominee and an endorsement by his or her department head. ***Nominations should be submitted to Provost Robert A. Brown no later than Friday, October 29, 1999***. If you have any questions about the nomination process, please contact Rosalind Wood, 3-208, 3-3036, rosalind @mit.edu.

All tenured, full-time members of the regular faculty are eligible for appointment as a MacVicar Faculty Fellow. For the first time this year, the Advisory Committee will consider three-year MacVicar Faculty Fellowships for junior faculty. These are convertible to regular 10-year MacVicar Faculty Fellowships if tenure occurs. A MacVicar Faculty Fellow may simultaneously be the holder of a named professorship.✥

TEACH TALK

New Research Points to the Importance of Using Active Learning in the Classroom

Lori Breslow

Over the last several years, researchers in what is now called learning science, which includes work in such fields as cognitive science, developmental psychology, neuroscience, and cross-cultural anthropology, have begun to make significant progress in understanding how learning takes place at the postsecondary level. They are creating an increasingly sophisticated picture of what happens in the college classroom from the perspective of both student and instructor. And they are describing with impressive detail how the system created by the interaction of learners, teachers, technology, and discipline operates.

In all this, one finding, in particular, is so consistent that it should be singled out for special attention. Put simply, it is this: Researchers have seen that when students themselves are actively involved in the learning process, their learning improves. This finding, far from being an abstraction of interest only to a small group of academicians in the field, has direct consequences for what we do in the classroom.

In other "Teach Talks," I have alluded to the positive effects that actively engaging students in their learning can have (see, for example, "Newsletter Introduces New Regular Feature," February/March 1995; "What the Students Say," November/December 1997; and "Teaching Teamwork Skills," January/February and, March/April 1998). So important is the finding that active learning contributes to students' improved performance, that the next three "Teach Talks" will be devoted to exploring this topic. In this column, I will present the data that underlies the claim for the efficacy of active learning techniques. In the next "Teach Talk," I will outline some specific ways science and engineering instructors can bring active learning into the classroom. And the third column in the series will describe specific ways active learning techniques are being used in MIT classrooms. This full picture of active learning will hopefully prompt some of you to experiment with it in your classrooms in ways you see fit.

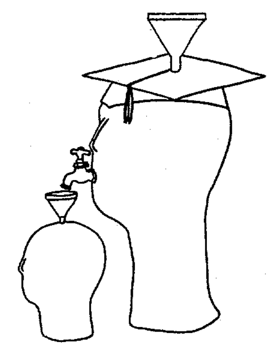
But before I begin, a definition of terms and a disclaimer.

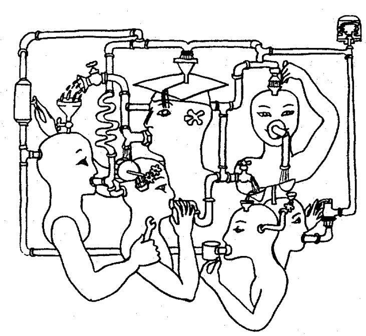
The phrase "active learning"– like many terms that have the misfortune of being too popular and too widely used – has taken on a number of meanings depending on the context in which it is being used and who is using it. It is sometimes used interchangeably with terms like "collaborative learning" or "cooperative learning," although I would argue that both are subsets of active learning. (More on this in the next "Teach Talk.") It can encompass a range of activities, from having students discuss a problem or a concept with one another during class to having them work on semester-long (or several semesters-long) design projects in teams. In this series, I am going to use "active learning" to describe both an approach to learning and a variety of techniques that are used if one employs that approach.

Active learning means, basically, that students are involved in some kind of guided activity in class, so that they are doing something in the classroom besides sitting and listening to the instructor give a lecture or watching him/her work problems on the board. This definition has two implications:

- In the classroom, students are not passive recipients of knowledge, but are engaged learners; and
- Teachers are not seen as founts of information, but function more as mentors or coaches.

Karl Smith*, a professor of civil engineering at the University of Minnesota and an authority on collaborative learning, uses the two illustrations below to show the differences in underlying philosophy between "traditional" learning and active learning. In the classroom as we know it, instructors try to "pour"





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Research Points to Importance of Active Learning

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knowledge into the heads of their students. Teachers who use active learning believe that knowledge can best be gained through the interaction of students, not only with them, but also with one another and with the material being taught.

The richest definition of active learning I have found comes from Richard Hake, a professor of physics at Indiana University. Hake, who uses the term "interactive engagement," writes that IE methods are "designed in part to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities which yield immediate feedback through discussion with peers and/or instructors." (p. 65). ("Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," *American Journal of Physics*, 66, 64-74, 1998.)

This does not mean, by the way, that students and teacher have equal roles in the classroom. A basketball coach and his/her players are not at the same level within the hierarchy of the team. But no one could argue that basketball players can become proficient at playing the game only by listening to the coach talk about it. They have to get out on the court, they have to practice with their teammates, and they have to play in front of the coach, so they can get feedback on their performance. Like athletes, students have to do physics or mathematics, chemistry or biology in order to master it. Doing it in front of both "teammates" and the "coach" in order to practice and receive feedback improves the student's ability to understand and apply the crucial concepts of the discipline.

Now to the disclaimer. I am not advocating – although some people would – that active learning should replace more traditional approaches, like lectures, across the board. Lectures have their advantages, and have their place in a methodological toolbox. Nonetheless, the research makes a fairly compelling case that some kind of involvement with course content *during class time* leads to gains in learning not seen using more conventional approaches. Let me, then, turn to those studies themselves.

Meta-Analysis Finds Gains in Achievement, Persistence, Attitude

One of the most persuasive studies comes from the National Institute for Science Education (NISE). Based at the University of Wisconsin - Madison and funded by the NSF, NISE is a group of faculty, researchers, and faculty developers who work to improve science, mathematics, and engineering education through research, publications, workshops, and assessment projects. In 1997, NISE published a research monograph, "Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta Analysis," by Leonard Springer, Mary Elizabeth Stanne, and Samuel S. Donovan.

Springer et al.'s meta-analysis is of 39 high-quality studies on the use of small-group learning. The original pool of studies was 383. In order to be included in the meta-analysis, a study had to: (1) examine undergraduates from an accredited postsecondary institution in North America; (2) look at small-group work among two to ten students; (3) have been conducted in an actual classroom; (4) have been published or reported in 1980 or later; (5) report enough statistical information to estimate effects size.

The metric used was the standardized mean difference (*d*-index) effect size. For two-sample analyses, effect size was calculated by subtracting the control group's average score from the experimental group's average score and dividing the difference by the average of two standard deviations. For single-sample analyses, the average score on a pre-test was subtracted from the average score on a post-test, and the difference was divided by the average of two standard deviations.

The authors write, "The main effect of small-group learning on achievement, persistence, and attitudes among undergraduates in SMET [science, mathematics, engineering, and technology] was significant and positive." (p. 7). Students who learned in small groups demonstrated greater achievement (d=0.51), persisted to a greater extent through SMET courses (d=0.46), and expressed more favorable attitudes towards their courses (d=0.55) than students who did not work collaboratively or cooperatively (see graphs, next page).

To put these findings into perspective: The average effect size for all classroom-based interventions on student achievement is 0.40 as compared to 0.51 for small-group learning. *The 0.51 effect size in achievement would move a student from the 50th percentile to the 70th on a standardized test*. The 0.46 effect size for persistence is enough to reduce attrition in a SMET course or program by 22%. And the 0.55 effect size for attitudes far exceeds the average effect of 0.28 for all classroom-based interventions.

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Research Points to Importance of Active Learning

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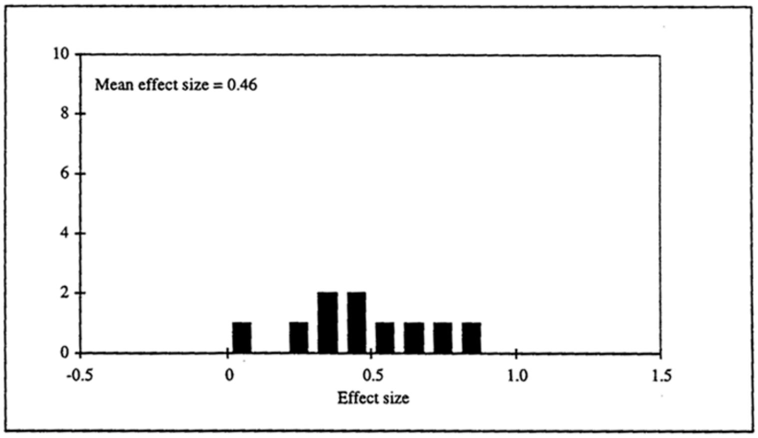
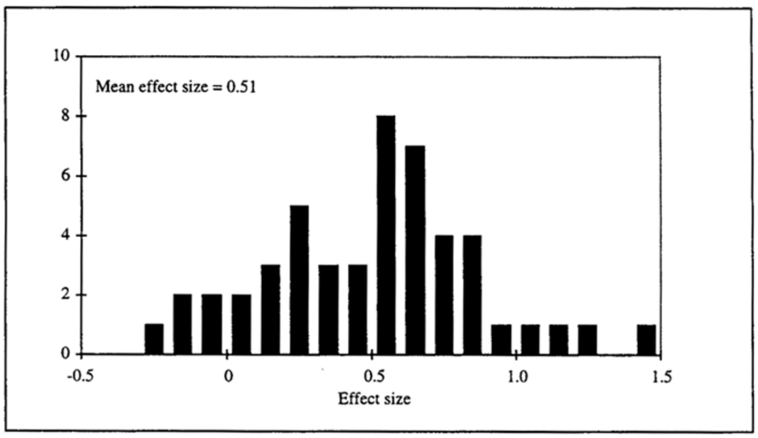
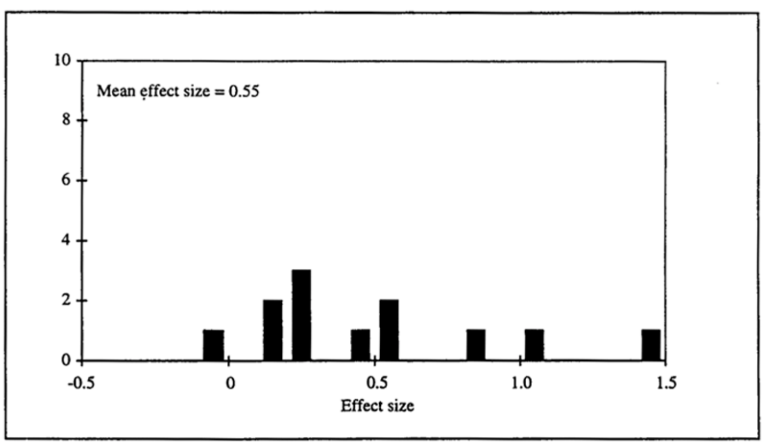
Students Using Active Learning Showed More Achievement



Students Using Active Learning Persisted More in SMET Courses



Students Using Active Learning More Positive About Courses



Physics Studies Also Report Positive Results

A significant body of research into learning has been done in physics, including, notable work by Lillian McDermott at the University of Washington, Edward Redish* at the University of Maryland, Richard Hake at Indiana University, and Eric Mazur at Harvard. (Each, by the way, is a physicist who has chosen to do research in physics education as well as research within the field itself.) The findings of the studies echo those of the studies in the Springer meta-analysis: Gains in learning are correlated with the use of active engagement methods.

Edward Redish, Jeffrey M. Saul, and Richard N. Steinberg examined 11 different introductory calculus-based mechanics classes for engineering students at the University of Maryland and reported their findings in "On the Effectiveness of Active-Engagement Microcomputer-Based Laboratories," which appeared in the *American Journal of Physics* (65, 45-54, 1997). Taught by six different instructors, each class was composed of three hours of lecture and one hour of a small section each week. However, in six classes the one-hour section was a traditional problem-solving recitation; in five classes the one-hour section was an interactive tutorial using micro-computer-based laboratory equipment.

Students were evaluated using questions from the Force Concept Inventory (FCI), a standardized, well-validated instrument used to measure how well students understand concepts from classical mechanics, and a long-answer examination question. The

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Research Points to Importance of Active Learning

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metric used was the figure of merit (*h*), which was defined as:

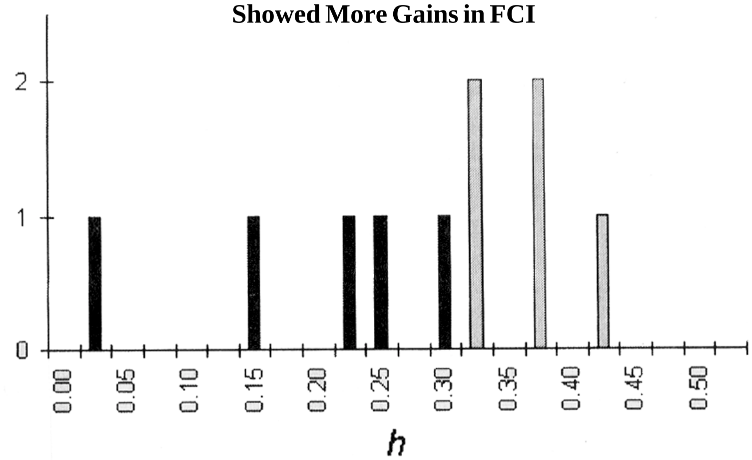
h = class post-test average – class pre-test average/100 – class pre-test average.

The tutorial classes systematically produced better overall FCI gains than the non-tutorial classes. The average fractional gains of the classes were:
<h> = 0.18 (classes with recitations)
<h> = 0.35 (classes with tutorials)

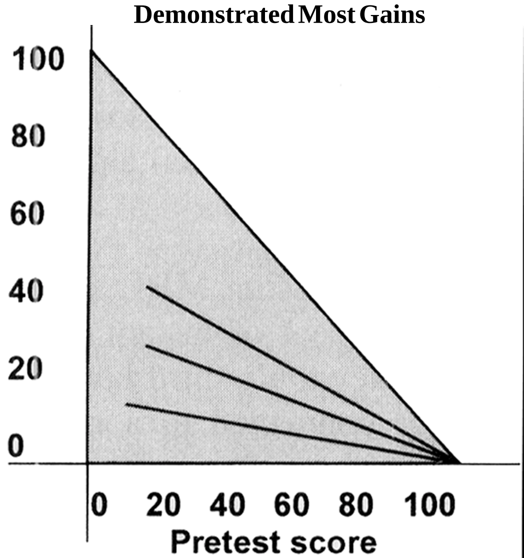
As Graph 1 shows, every non-tutorial class had a larger *h* than every non-tutorial class. (Light colored bars are the tutorial classes; dark-colored bars represent the recitation classes. Only 8 classes are depicted because not every class in the 11-class study was given the FCI.)

Results were somewhat disappointing on the long-answer examination question, which asked students to generate a velocity vs. time graph for a complicated situation. However, the tutorial students did better than recitation students. While only 12% of the recitation students were able to draw a correct graph, 22% of the tutorial students were able to do so.

Graph 1
Students In Tutorial Classes Showed More Gains in FCI



Graph 2
Courses That Used IE Methods Demonstrated Most Gains



Richard Hake, in the article cited above, examined the effect of using what he calls "interactive engagement" by surveying 62 introductory physics courses, including courses in high schools, colleges, and universities, with a total enrollment of 6542 students. Students were evaluated using the Force Concept Inventory (FCI). The measure of the average effectiveness of a course in promoting conceptualized understanding was taken to be the average normalized gain <*g*>, which was defined as:
<*g*> = % <post> - % <pre>/100 - % <pre>

Fourteen traditional courses (N = 2084) that made little or no use of interactive engagement (IE) methods achieved an average gain of 0.23 plus or minus 0.04 std dev. Forty-eight courses (N = 4458) that made substantial use of IE methods achieved an average gain of 0.48 plus or minus 0.14 std dev., almost two standard deviations above that of traditional courses. On Graph 2 (which appears in the Redish study cited above) gains made in traditional courses are represented by the line closest to the x-axis; gains made in courses using IE methods are shown by the middle line; and gains made by IE courses using a research-based text are depicted by the steepest line.

Why Is Active Learning So Effective?

I can't provide a definitive answer to the question of why we see the

(Continued on next page)

Research Points to Importance of Active Learning

Breslow, from preceding page

results we do when active learning techniques are used, but research in neuroscience and cognitive psychology, which confirms earlier theories put forth by developmental psychology, is beginning to provide us with a glimmer of an explanation.

The picture of the brain emerging from this research is that of an organ continually molding itself by making synaptic connections. Of more importance to the argument here is that this process is influenced through the interaction of the individual with his/her environment. In other words, as John D. Bransford, Ann L. Brown, and Rodney R. Cocking write in their well-received new book, *How People Learn: Brain Mind, Experience, and School*, "Learning changes this physical structure of the brain" (p. 103). They then go on to write, "These structural changes alter the functional organization of the brain; in other words, learning organizes and reorganizes the brain" (p. 103). While once it may have been thought that brain development occurred only in children before a certain age, we now know that the process of synaptic addition occurs throughout an individual's life.

And this is a process that unites quantity with quality: that is, the more the brain is stimulated because the individual is in a rich environment, the more brain activity. For example, Bransford and his co-authors, citing a study by J.E. Black and others, report animals raised in complex environments have a greater volume of capillaries per nerve cell than animals raised in sterile cages. ("Complex Experience Promotes Capillary Formation in Young Rats Visual Cortex," *Neuroscience Letters*, 83, 351-355, 1987). Other studies Bransford, Brown, and Cocking include in their book support this finding that "experience increases the overall quality of functioning of the brain" (p. 107). Here, of course, I am simply scratching the surface of a complex body of research. I would urge you to read *How People Learn* yourself, not only for its description of research on the brain, but for interesting findings on science teaching as well.

The picture of the brain emerging from this research is that of an organ continually molding itself by making synaptic connections. Of more importance to the argument here is that this process is influenced through the interaction of the individual with his/her environment. In other words . . . "Learning changes this physical structure of the brain.". . . And this is a process that unites quantity with quality: that is, the more the brain is stimulated because the individual is in a rich environment, the more brain activity.

While it may be a leap from animals in stimulus-rich cages to a college classroom, the research that confirms that the brain continues to change throughout the human life span allows me to ask this question: Isn't it possible that by marrying what we know about the physiology of the brain with the research findings on active learning, we can at least posit a hypothesis for why active learning is such a powerful teaching technique? Active learning allows for more intense engagement on the part of the students which, if the brain research is right, should produce more substantial learning.

Possible Weaknesses in the Argument

When I have presented these findings on active learning in workshops with MIT faculty, several questions and criticisms arise without fail. MIT faculty are a dubious lot, and changes in conventional methods of teaching are not to be taken lightly. Therefore, I think it is important to surface several of these concerns:

• *There are methodological flaws in the studies cited.* Hardly a study in social science goes by without some concern over methodology, and these are no exception. Both Hake and Springer address possible methodological difficulties. These range from the problems associated with meta-analysis due to the fact that journals tend to publish studies that report statistically significant results (Springer, p. 18), to the problem of "teaching to the test" in the studies where gains in the FCI are used to measure effects (Hake, p. 69).

(Continued on next page)

Research Points to Importance of Active Learning

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It is impossible for me to address all these methodological concerns here. (Please contact me if you would like copies of the articles, and/or would like to discuss specific problems in methodology.) What I can say is that the authors are aware of these limitations, and have taken care to deal with them within the constraints imposed by social science research. In addition, the studies cited have been well received in the field; the Hake and Redish studies appear in peer reviewed journals.

• *Aren't what we are seeing simply another version of the "Hawthorne Effect"?* The "Hawthorne Effect" is a term coined from studies undertaken at the Hawthorne Works of the Bell System's Western Electric plant between 1924 and 1933 on, among other things, worker productivity. The common interpretation of the studies' results is that when changes are made to an environment in which a group operates, the group's members will respond positively not because of the intrinsic worth of the intervention, but simply because they are being given special attention.

Although there is great debate over exactly what the Hawthorne experiments do show, even if the above interpretation is true, the NSIE study reports a significantly larger positive effect for active learning than other kinds of interventions (p. 17). In other words, even if most every intervention produced positive results (a claim which, in actuality, can't be made), active learning remains a technique that results in *more* gains than other techniques. In addition, Hake reports positive gains in courses in which active learning has been employed for a number of years (p. 70).

• *These findings may be applicable to other college-level students, but MIT students are different.* Hake's is the only study I have read that discusses a correlation between students' academic ability and their responsiveness to active learning techniques, and it reports higher gains for honors high school students than for those in regular courses. It does make sense to me that highly intelligent students would derive great benefit from the ability to engage with ideas and concepts directly under the watchful eye of a gifted teacher, but that's only gut-level instinct. It would be an interesting – and important – contribution to the research literature if we could undertake a study to test that hypothesis.

As promised, this "Teach Talk" has examined the more conceptual, research-oriented part of active learning. I hope I have made the case that this is a tool to be used, explored, experimented with. In the next "Teach Talk," I'll take a more concrete approach, describing the range of techniques that can actually be put into practice in science and engineering classrooms.✥

Indicates speaker who participated in last year's series "On the Cutting Edge: Innovations in Science and Engineering Education." A videotape of the speaker's presentation may be obtained by calling or writing the Teaching and Learning Laboratory, 253-3780, tll@mit.edu.

[Lori Breslow can be reached at lrb@mit.edu]

Do You Use Active Learning in Your Classes?

If so, please contact the Teaching and Learning Laboratory at tll@mit.edu or 253-3371. Faculty in the Schools of Science and Engineering would like to talk with others who have experience with active learning techniques in order to share information.

ESD Created to Broaden Engineering Education

Roos, from Page 1

and intellectual home for engineering systems faculty to develop educational and research programs, facilitate the admission of students to various interdisciplinary academic programs, and provide governance on key issues such as faculty hires, promotion, and tenure. ESD also explores the changing roles and relationships among universities, industry, and government in all phases of engineering systems development. What follows is a discussion of the rationale for establishing ESD, its history, and its progress to date.

The field of engineering is changing rapidly. Systems and product complexity are increasing at an accelerating pace, as are the complexities of operating in an environment where technical, natural, and social systems increasingly intersect. In addition, the world faces unprecedented social concerns in an expanding global marketplace. Systems and products today must be environmentally benign and health-protective, and in some cases must even meet baseline aesthetic standards in order to avoid legal, political, and other barriers to success in the marketplace. This requires an integrative approach in which engineering professionals view the technological components as part of a larger engineering system.

In response to the changing design environment, some universities have developed systems-based programs. MIT has been in the vanguard of this effort with a wide range of systems-related initiatives in education and research. Five master's-level interdisciplinary educational programs at the Institute are serving over 400 students today. These educational programs include Leaders for Manufacturing (LFM), System Design and Management (SDM), Technology and Policy Program (TPP), Master of Science in Transportation (MST), and Master of Engineering in Logistics (MLOG).

Several research centers have also been active in focusing on engineering systems problems. They are the Center for Innovation in Product Development (CIPD), Center for Technology, Policy and Industrial Development (CTPID), Center for Transportation Studies (CTS), and Industrial Performance Center (IPC). These centers are interdisciplinary, involving faculty from engineering, management, and the social sciences.

The Engineering Systems Division brings together these academic programs and research centers to facilitate cooperation among the participating faculty. ESD provides an intellectual home and institutional framework for the faculty to "go the next step," building upon the successful programs already developed.

ESD's mission is to establish engineering systems as a field of study focusing on complex systems and products, where these systems and products are viewed in their broad social and industrial context, and to use the new knowledge gained to improve engineering education and practice.

Motivation for the Division

Industry has recognized the need to respond to the aforementioned new design and competitive factors and to have all of them considered in achieving design solutions. It is useful to look at these factors more closely in order to fully understand and appreciate the need for a more integrative approach in which engineering professionals view the technological components as part of a larger engineering system.

As an example of the broadened perspective of engineering systems, consider how changes in automotive design have motivated new educational and research initiatives at MIT. The automobile, once considered a technologically mature product, is now influenced by new technology, including lightweight materials; "smart" electronic components, and alternative propulsion systems to the internal combustion engine. The globalization of the automobile industry has caused locational shifts of both design and manufacturing facilities from a national to international context. Concerns such as quality, management of human resources, and time-to-market have motivated fundamental changes in automotive product development, manufacturing, and supply-chain design. And new approaches – such as just-in-time inventory control, integrated product development teams, and lean production techniques – have reshaped companies' automobile production processes, while social concerns such as air pollution, recycling of materials, global warming, and safety also have had a major impact on auto design and production.

Furthermore, design and manufacturing are only part of the automotive system. Government policies determine the role of automobiles in providing personal mobility, ensure automotive safety, and affect the impact of automobiles on the environment and urban development. The formation of these policies requires not only technical expertise but also an understanding of

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institutions, human behavioral responses and other non-technical considerations.

These changes in automotive systems have served as an impetus for the development, over the years, of many new MIT educational and research programs sponsored by automotive companies. GM, Ford, and Chrysler are members of LFM and GM and Ford are also sponsors of CIPD. [Chrysler has recently ended its sponsorship of LFM.] Ford has the largest number of students enrolled in SDM of any company. Volkswagen is a sponsor of the CTS Supply Chain Management Program. All the world's auto companies participate in the International Motor Vehicle Program at CTPID. TPP offers a proseminar on the electric car as an automotive system. CTPID has a global mobility program and CTS has an intelligent transportation systems program and numerous other transportation research projects.

Automotive systems provide but one example of how MIT has developed new educational and research programs that focus on complex engineering system problems. Increasing complexity can also be found in many other systems (e.g., telecommunications systems, energy systems, and aeronautical systems), which are the bases for similar programs.

These programs educate engineering systems professionals who view the technological system as part of a larger whole. For them, the context in which the system operates is a design *variable* rather than a constraint. Thus, they are concerned with the design of the organization that has to manufacture the product, the regulations and public policies governing its use and disposition, the marketing of it, and the relationship with suppliers, distributors and other participants in the value chain. From this perspective, the design process includes: the physical attributes which are the domain of traditional engineering; the process attributes, which are the domain of both engineers and managers; and the context attributes which traditionally have been the domain of managers, governments, and social scientists.

In spite of numerous accomplishments over the past several years, both industry and the academic community have been moving incrementally, largely independently, and with no widely accepted strategic vision of engineering systems to guide them. In the early stages of a major change in the practice of engineering, such incrementalism makes sense. However, with the experience base developed to date, the time is right for the first comprehensive effort to define the nature of engineering systems, and to encourage both industry and the university community to act on the resulting vision. Indeed, given the pace of change, the need for such an effort grows more urgent day by day.

Such an initiative represents a massive challenge. In the post-World War II era, MIT revolutionized engineering by developing engineering science as a new and broadly applicable approach in many engineering disciplines. The primary results of this effort were the publication of a now classic engineering science approach, and the impact of MIT graduates schooled in the new approach on universities throughout the world.

The move to engineering systems is expected to have similar impact; yet it also represents a considerably more complex undertaking. To be truly effective, engineering systems require leaders who are well-versed in a range of areas beyond the elements of the core engineering disciplines; these areas include management and the relevant social sciences. These new educational and research programs require different engineering approaches from those of the traditional engineering science paradigm – which has served as the driving force in the School of Engineering during the past several decades. We need to develop an integrative approach to engineering systems problems that considers the context in which the systems are initiated, designed, manufactured, constructed, implemented, and maintained.

What is the Engineering Systems Division?

In response to this need, ESD was first proposed by the Eagar Committee, which was appointed by the dean of Engineering in 1995 and chaired by Tom Eagar, head of the Department of Material Science and Engineering. The Committee concluded that to be a leader in engineering education and research well into the next century, MIT required a mix of faculty, staff and students involved in engineering systems. Moreover, the Committee found that leadership in engineering education and research requires that MIT have strengths in as well as a balance between both the disciplinary aspects of engineering science as well as the integrative aspects of engineering systems.

A survey of Engineering School department heads and center directors conducted by the Committee found

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the School of Engineering had only about half as many faculty spending time on integrative activities in engineering systems as was needed. These current engineering systems faculty were too few and too dispersed among departments to form a critical mass. Additional faculty members in engineering systems were needed to work with the existing limited faculty resources. Furthermore, these faculty members needed an intellectual home for educational and research programs in engineering systems. The Committee therefore recommended in its August 1996 report the creation of a Division of Engineering Systems within the School of Engineering and the appointment of an associate dean of Engineering to head the Division.

ESD was described in the Eagar Report as "an organizational unit with porous boundaries that would cut across, and interact with, the eight engineering departments. An important function of the division structure is preventing the isolation of faculty in this area and the removal of valuable resources from existing departments that might occur with a departmental structure."

In September 1997, Dean of Engineering Bob Brown appointed Daniel Roos as associate dean of Engineering Systems and established the Engineering Systems Council and the Extended Engineering Systems Council. The Engineering Systems Council consisted of the heads of the interdisciplinary engineering systems academic programs and research centers in the School of Engineering. The Extended Engineering Systems Council was a group of approximately 30 faculty from organizations throughout MIT who had an interest in engineering systems.

At the request of Dean Brown, both Councils developed further the concepts of engineering systems and an implementation plan that served as the basis for the Division's creation. That plan was discussed by the Faculty Policy Committee and Academic Council, as well as at the Institute faculty meeting. The Executive Committee of the Corporation subsequently approved it and ESD began operations on December 1, 1998.

Schematically, the interrelationships between the Division, the School of Engineering Departments, and other schools and programs are depicted in Figure 1, below.

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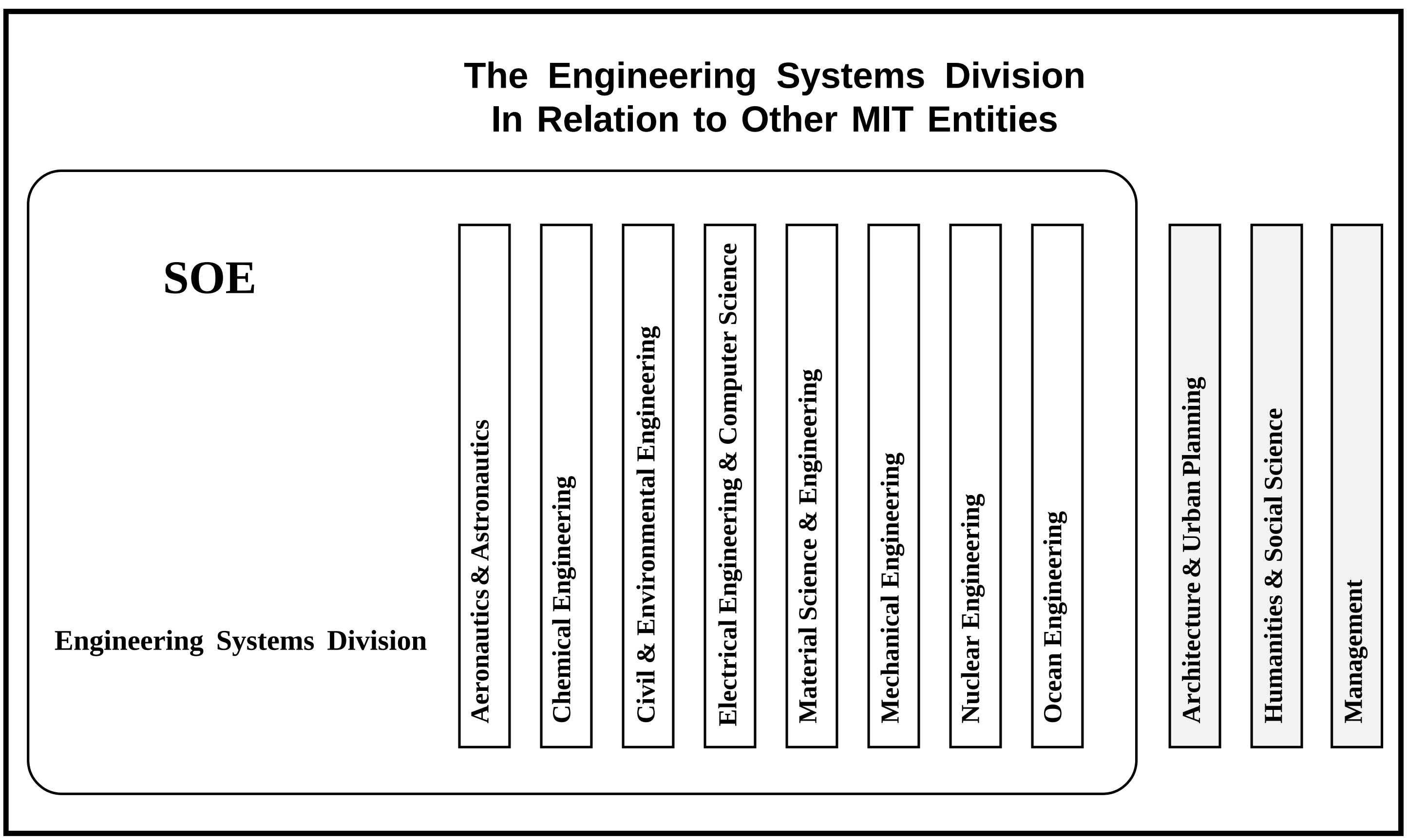

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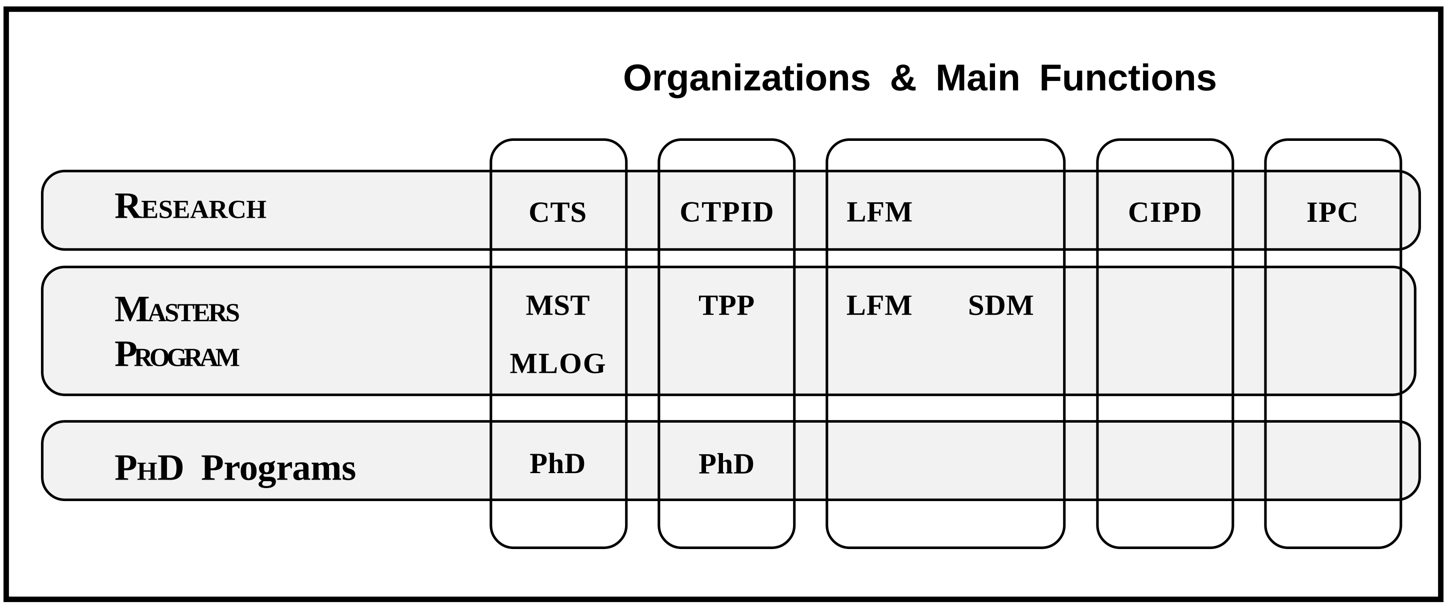
Figure 2, below, depicts the organizations that are part of ESD. There are six units, four of which administer five different educational programs at the Master's level. In addition, several discussions have taken place with the Operations Research Center (ORC), regarding potential cooperation with the ESD. Other units at MIT may decide to affiliate with or join ESD in the future.



An integrative approach to engineering problem solving requires a shared commitment between ESD, the Engineering School departments, and the participation of colleagues in the management and social sciences. As Provost Bob Brown has stated, "The School of Engineering is placing growing emphasis on engineering research and educational programs that integrate traditional engineering expertise with management and social science."

The School of Engineering departments have different degrees of interest in engineering systems. The relationship of the Division to each of the departments will vary depending on the departmental need and desire. The goal of the Division is to *add value* rather than simply duplicate what can be done effectively by the departments, the Sloan School of Management, the School of Architecture and Planning, or the School of Humanities and Social Sciences.

ESD Faculty

ESD has a similar structure to the Division of Bioengineering and Environmental Health, which began operations on July 1st 1998. ESD is composed primarily of "dual" faculty. Such dual faculty will commit their time and efforts about equally between a department and ESD. In most cases, a formal 50/50 split of responsibility for academic salary, promotion and tenure, teaching duties, and a faculty member's administrative responsibilities will characterize this. In other cases, faculty may have a traditional joint appointment with ESD. These faculty generally spend less than half time in ESD activities and their tenure line remains with their home department.

This split of responsibility is a formality (such as for accounting purposes) necessary for ESD to be successful. The objective is for ESD faculty to pursue activities that benefit *both* their home department and the Division and thereby add value to both units via the synergism which ESD is designed to promote. Furthermore, ESD faculty should be able to leverage the work of their departmental colleagues, thus adding further value to the departments, the Division, the Schools and the Institute.

That dual or joint appointments are shared with the departments is a distinguishing feature of ESD relative to traditional MIT department appointments. This is consistent with the concept that the new entity is charged with bringing engineering systems into the School of Engineering

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ESD Created to Broaden Engineering Education

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by interacting with the departments as strongly as possible. Symbolic of that commitment, two of the ESD faculty are current department heads (Professor Tom Eagar of Material Science and Engineering and Professor Ed Crawley of Aeronautics and Astronautics) and four ESD faculty are former department heads (Professor Joel Moses of Electrical Engineering and Computer Science, Professor Earll Murman of Aeronautics and Astronautics, and Professors David Marks and Joseph Sussman of Civil and Environmental Engineering).

MIT faculty with ESD appointments are listed in the table. These faculty come from the Schools of Engineering and Management. We also anticipate social science faculty joining ESD from the School of Humanities and Social Sciences and the School of Architecture and Planning.

The initial ESD appointments are all senior faculty members. There were discussions about also having junior faculty in the new division. Some felt that junior faculty should not be appointed in ESD since their tenure process would be more difficult; the junior faculty member would have to be evaluated by two different units. Others argued, as in any academic unit, the inclusion of junior faculty is vital over the long term in order to provide renewed energy, new ideas, and a constant evolution of the unit. In particular, junior faculty with fresh ideas are critical to an emerging field such as engineering systems and, therefore, they should be included in ESD. We decided that junior faculty could join ESD if a senior faculty member agrees to serve as a mentor and the junior faculty member is aware of the potential additional difficulties in the tenure process.

To respond to the current shortfall of engineering systems faculty, identified by the Eagar Committee, an ESD Faculty Search Committee has been established. Members of the Committee during the past academic year included: Professor Joseph Sussman of Civil and Environmental Engineering (Chair), Professor Tom Eagar of Material Science and Engineering, Professor Stephen Graves of the Sloan School of Management, Professor David Hardt of Mechanical Engineering, Professor Greg McRae of Chemical Engineering, Professor Harvey Sapolsky of Political Science, and Institute Professor Sheila Widnall.

MIT Faculty with ESD Appointments

Faculty Member	Affiliated Unit
Thomas Allen	Sloan School of Management
Joel Clark	Materials Science and Engineering
Ed Crawley	Aeronautics and Astronomics
Richard deNeufville	Civil and Environmental Engineering
Tom Eagar	Materials Science and Engineering
Steven Eppinger	Sloan School of Management
Stephen Graves	Sloan School of Management
Dave Hardt	Mechanical Engineering
Maurice Holmes	Sloan School of Management
Thomas Kochan	Sloan School of Management
Paul Lagace	Aeronautics and Astronomics
Stuart Madnick	Sloan School of Management
David Marks	Civil and Environmental Engineering
Fred Moavenzadeh	Civil and Environmental Engineering
Joel Moses	Electrical Engineering and Computer Science
Earll Murman	Aeronautics and Astronomics
Amedeo Odoni	Aeronautics and Astronomics
Daniel Roos	Civil and Environmental Engineering
Yossi Sheffi	Civil and Environmental Engineering
Joseph Sussman	Civil and Environmental Engineering
John Williams	Civil and Environmental Engineering

Educational Challenges and Opportunities

The principal initial challenges and opportunities for ESD are educational. A first mission for the Division is an examination of the "systems" aspects of the five ongoing programs (i.e., what are their elements, what are their major interactions, etc.). From this, improved efficiencies and new intellectual pursuits will emerge. For example, LFM and SDM have recently decided to consolidate their administrative functions.

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ESD Created to Broaden Engineering Education

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The key to defining and propagating the intellectual core of ESD is a coherent curriculum targeted at students with interests in engineering systems. Some basic elements of a divisional curriculum are in place, as evidenced by the numerous common topics among the programs included in ESD. However, most of the specific subjects have not been designed by the programs themselves, and thus were not intended to be part of any particular degree. Conversely, some subjects have been developed with a narrow view of supporting only a single program and do not have a broader intellectual mission.

Accordingly, ESD will support development of subjects directly tied to the underlying concepts of engineering systems while continuing to adapt and modify existing subjects through enhanced collaboration among the existing ESD programs. Consistent with the mission of ESD, all new subjects will be joint offerings, primarily with the engineering departments, but also in many cases with management and the social sciences departments.

The Division has recently begun a new project to develop engineering systems case studies to demonstrate the principle of engineering systems in a real world context. These case studies could be utilized not only by engineering systems subjects, but also by subjects offered by engineering departments.

A common characteristic of most ESD research and educational programs is their deep involvement with industry, in ways that provide more than funding for the programs and employment for our students. These programs interact with industry and government to define research and educational needs and address the identified needs.

Working with Industry

A common characteristic of most ESD research and educational programs is their deep involvement with industry, in ways that provide more than funding for the programs and employment for our students. These programs interact with industry and government to define research and educational needs and address the identified needs. ESD works with industry in a partnership mode where industry serves as a real-world laboratory to test new concepts, provide data and facilities, and help faculty and students better appreciate the context of their research. Several ESD academic programs feature an internship experience at an industrial site.

ESD units have formal ties to multiple enterprises and novel industry-academic relationships. Examples of industrial relationships include LFM's industry partners, CTPID's International Motor Vehicle Program and Lean Aerospace consortia, CTS's Corporate and Public Affiliates Programs and its Integrated Supply Chain Management Consortium, SDM's and CIPD's corporate partners, IPC's industry studies, TPP's student government and industry internships, and LFM's student industry internships. These programs explore new ways to work with industry and government thus providing a better understanding of the changing relationships between universities, government and industry, as well as better educational opportunities and programs for our students.

Conclusion

The establishment of ESD continues to keep MIT in the vanguard of engineering research and education. ESD will help to further the development of new approaches, frameworks, and theories to better understand engineering systems behavior and design. ESD faculty will develop and support educational programs on complex systems and design synthesis that will prepare students for leadership positions. And the Division itself will set the pace for evolving roles and relationships among universities, industry, and government in all phases of engineering systems development.✣

[Daniel Roos can be reached at drdr@mit.edu]

The Year 2000 Team

Some FAQs Concerning the Year 2000 (Y2K)

Mike Drooker and Gayle C. Willman

Y2K will arrive on time: *fewer than 90 working days from now*. Be sure you and your department, laboratory, or center are prepared for Year 2000. While MIT's existing contingency and business continuity plans are being updated to address Y2K-specific issues, it is important that departments, labs and centers (DLCs) do their part to plan a smooth transition to the Year 2000.

Plan now for the New Year's weekend.
Now is the time to plan your activities for the New Year's weekend. *Health and safety issues are paramount.* The MIT Safety Office reminds MIT researchers it would be safest to curtail the more hazardous experiments during the transition when the safety systems and emergency response abilities may not be at their normal levels. For questions or concerns, contact the Safety Office at: x3-4736 or send e-mail to safety@mit.edu.

Know what you are responsible for.
At MIT, each department, laboratory and DLC is financially and functionally responsible for the Y2K compliance of its own equipment and overall Y2K readiness. For example, users in most areas are responsible for updating their own desktop computers. See: <http://mitvma.mit.edu/mity2k/y2kcomp.html> or download a step-by-step guide from: <http://web.mit.edu/is/isnews/insert.pdf>.

In some cases, responsibilities span departmental boundaries. For example, MIT Facilities has responsibility for the preparation of buildings, HVAC systems, elevators, and utilities. MIT Information Systems has responsibility for most (but not all) centralized server systems, the campus computer network (central authentication, e-mail, and Web services), and the campus phone system.

MIT's contractor (TAVA) inventoried, tagged, and evaluated over 6000 pieces of equipment containing embedded processors. See your administrative officer for the evaluation of the TAVA-tagged equipment.

Check your supply chain.
Acquire critical and/or long-lead-time supplies immediately. If your work relies on external support which is beyond your control, consider whether you are able to suspend work-in-progress during the weekend.

Do your own IART.
IART stands for Inventory, Assess, Remediate, and Test. Survey your work area. Identify and list items that are important to your work. Prioritize the list. Assess the Year 2000 vulnerability of each item. Use TAVA evaluations where applicable. Other resources are listed below.

Remediate non-compliant items that are important to your activities: repair, replace, upgrade, or discard. Test your remediated systems, but *only* in a safe prototype environment, *not* with "working" systems or "real" data.

Devise and maintain an appropriate backup strategy for your computer systems.

The regular backup of servers and desktop machines is prudent in general, not just for Y2K. Purchase backup media immediately for local backups. Alternatively, consider MIT's online ADSM backup service. For information see: <http://web.mit.edu/is/help/adsm/>. Registration by November 30 is recommended for Y2K preparation.

> ***Misinformation regarding Y2K is rampant.***
> **These resources address "hype" and rumors:**
> - **Computer Professionals for Social Responsibility: <http://www.cpsr.org/program/y2k/>.**
> - **Federal Year 2000 Information Center: 1-888-USA-4-Y2K.**
> - **President's Council on Y2K: <http://www.y2k.gov/java/whatsnew1.html>.**

Are your contingency plans in place?
Know your local emergency action plan, and decide what you'd do if a

(Continued on next page)

Some FAQs Concerning the Year 2000 (Y2K)

Mike Drooker and Gayle Willman

Year 2000 problem (or any other unusual, unpredictable situation) affected your work.

• Identify critical supply or service needs. Make a plan just in case your normal suppliers are unavailable. Would you have to shut down work-in-progress in such an event?

• Would you be inconvenienced by delays in international travel?

• What would happen if your building lost utilities? Plan ways to secure your work if it's necessary to minimize loss.

• Be sure your UPS batteries are at capacity.

Stay informed.

New and updated information about anticipated events and equipment issues is generated frequently. Your local "Y2K-Partner" can help identify changes that could affect your work. (Your AO can give you the name of your partner.)

Misinformation regarding Y2K is rampant.

These resources address "hype" and rumors:

• Computer Professionals for Social Responsibility: <http://www.cpsr.org/program/y2k/>.

• Federal Year 2000 Information Center: 1-888-USA-4-Y2K.

• President's Council on Y2K: <http://www.y2k.gov/java/whatsnew1.html>.

Will MIT delay the start of classes in January 2000?

No changes to the academic calendar are anticipated; IAP classes will begin as scheduled on Tuesday, January 4.

What plans are being made for the New Year's Transition?

To address Y2K-specific risks and effect a smooth transition to the Year 2000, MIT's Business Continuity Management Team (BCMT) has formed a Y2K Transition Team to enhance MIT's existing contingency plans. From December 31 through January 4, the Y2K Transition Team will also coordinate the execution of MIT's contingency plans if necessary. For additional information, see: <http://web.mit.edu/bcmt/>.

Facilities and Information Systems will have some staff on campus during the New Year's Transition Weekend to address any service disruptions that may arise. Other departments may select staff to assess departmental systems, and take any needed corrective action. Otherwise, staff should report to work on their regular schedules.

Details about the New Year's Transition Weekend will appear in the next issue of the *Faculty Newsletter*.

Will Y2K issues affect Security Systems?

The MIT Card is being verified for Y2K Compliance. We do not anticipate any problems involving systems that rely on the Card. If your space or laboratory relies on a security system provided by an outside vendor, verify compliance soon.

How will MIT community members who are away during the break learn about any changes in plans for the start of the quarter?

Communication channels will be in place so that the MIT community can obtain the latest information on any Y2K-related disruptions that affect the campus. Details will be provided in November.

Resources for IART and other information.

• MIT Y2K Partners. Consult the Y2K Partner in your area. Your AO can tell you who your representative is.

• MIT Year 2000 Team (for MIT only):

e-mail: y2k-help@mit.edu
voice mail: 253-2000

• MIT Year 2000 Team Web page at: <http://web.mit.edu/mity2k/>.✥

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MIT Project Year 2000 also provides links to manufacturers/vendors who provide Y2K compliant fixes for operating systems and many popular software programs for both the PC and the Macintosh: **<http://mitvma.mit.edu/mity2k/y2kcomp.html>.**

Programs supported include:

- Win 95/98, NT
- Microsoft Office
- PageMaker
- Acrobat
- Norton Utilities
- FileMaker Pro

Proposal to Change the P/NR Grading System

Merritt & Steinberg, from Page 1

But at the same time, it is important to instill in students a sense of high standards, of excitement about learning, of intellectual curiosity, and of life-long learning. Above all, we hope that students develop a sense of responsibility for their own learning, rather than leaving it up to the faculty to motivate or direct that learning. Moreover, we hope that students are serious about their classes and do not abuse the grading system to "get through" the freshman year with as little effort as possible. Learning is hard work: it requires good study habits, a good attitude, and willingness to learn.

We have taught at MIT for many years, and spent much time talking to colleagues about their perceptions of the learning process here. We have also listened to many students discuss their educational experiences here, and we have talked to many students after they have been in the workplace for a number of years. We come away from these various conversations with a number of observations.

Clearly the first semester of P/NR is very useful and should be retained as it stands now. But the second semester of P/NR is a detriment in several respects.

First, it offers no real transition to the grading system here, so that sophomores hit a "grade wall" which can be crippling.

Second, sophomore subjects (like 5.60 and 6.001) are squeezed into the freshman year so that they can be taken on P/NR. Freshman performance is fine in these subjects, but much of the rest of the freshman curriculum suffers as a result of taking these demanding sophomore subjects at that time.

Third, students squeeze all the Science Core into the freshman year in order to take it on P/NR. This ignores one of the best recommendations of the 1988 Report on the First Year (see below) which pushed hard to have the Core distributed over 2 years, opening the first year up to more exploration.

Fourth, some students load themselves up with more extra-curricular activities than they can possibly accommodate with their subjects, and allow their classes to slide since they are "merely" graded P/NR.

Clearly the first semester of P/NR is very useful and should be retained as it stands now. But the second semester of P/NR is a detriment in several respects . . . . Third, students squeeze all the Science Core into the freshman year in order to take it on P/NR. This ignores one of the best recommendations of the 1988 Report on the First Year. . . which pushed hard to have the Core distributed over 2 years, opening the first year up to more exploration.

Fifth, that sense of high standards and love of learning alluded to above is severely undermined by P/NR since it gives to students the strong impression that the faculty itself does not value subjects which they grade so loosely.

Certainly some students use P/NR in the second semester as a means for exploring their interests, but it is not clear why grades should inhibit that exploration.

Some History

Before making our proposal we will review briefly the history of the P/NR system at MIT. In 1968, the MIT faculty voted to conduct a 4-year trial of a radical departure from the traditional grading system for first-year students. Designated PASS/FAIL, the experimental system called for transcript use of the letter P (Pass) for performance in any subject at the ABCD level, and F (Fail) for performance below D level.

Reviewing this trial in 1972, the Committee on Evaluation of Freshman Performance concluded that, in general, the new system was regarded (hugely by students, if less so by faculty) as a distinct success and worthy of indefinite extension. It eased the formidable transition-of-entry for incoming undergraduates, afforded them somewhat more flexibility in selection of subjects, and encouraged them to focus on the substance of learning rather than on grade-outcomes.

In one respect, however, the Committee found the new system defective: by allowing a recorded grade of F for any subject in which the student's work did not warrant a passing grade, PASS/FAIL lost its opportunity to provide what later came

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Proposal to Change the P/NR Grading System

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to be called "disaster insurance." In the context of increasing diversity of background and preparation among students admitted to MIT, it seemed reasonable to the Committee that, during the freshman year, non-passing performance in a subject should leave no "scar" on the transcript. The committee therefore recommended that for a two-year experimental period no non-passing grade be recorded on the transcript (and, indeed, that the transcript bear no evidence that the subject in question had ever been registered for in the first place).

Thus, in 1974, after a satisfactory two-year trial period, PASS/NO RECORD replaced PASS/FAIL as the grading system for both terms of the freshman year.

For the sake of concision, from here on, we will not narrate in detail each of the numerous occasions on which the P/NR system has been discussed by the MIT community. One, however, is distinctly worth mention. In May 1988, a specially constituted Committee on the First-Year Program, after exhaustive consideration of the freshman experience, submitted to CUP a report recommending that, in the spring term, P/NR for freshmen be replaced by an arrangement under which, in each of the seven semesters following the first of freshman year, a student have the option of designating (by Add Date) one subject to be graded Credit/No-Credit, up to a maximum of seven subjects, with limits on the number of these that could be used to satisfy various Institute Requirements. When CUP brought this motion to a faculty vote a year later (May 1989) it was spiritedly opposed by a group (Groisser/Keyser/Meldman/Merritt/Vandiver) offering a substitute motion specifying that (1) the grade of Pass would in future denote C or better performance and that (2) freshman registration be capped at 54 units for fall and 57 for spring. The replacement motion carried, leaving the freshman grading system where it is today.

Finally, we would like to note that some of the second semester science core subjects are perceived as covering too many topics in too short a time and thus in some sense inundating the students. We hear of excessive "pace and pressure" from these subjects. We would like to discuss with the faculty teaching these subjects (in Math and Physics) the possibility of reducing that pace, and perhaps covering fewer topics in greater and more intense depth. Our students are very gifted and capable, and ultimately interested in learning things that they will need for their careers. The faculty needs to work towards making students aware of the necessity and importance of these science core subjects, and the materials which they cover.

Proposal

To address the many points above, we are recommending the following changes in the grading system.

On balance, it seems to us appropriate to create in spring term a system which allows freshmen to ramp up more gradually toward the real thing (which they will encounter as sophomores). The key to our proposed system is that, while allowing students to strive for higher grades in spring, it preserves through the entire year the disaster insurance feature. We think it is a workable compromise. Thus we propose that, starting in AY 2000-2001:

1) Freshman first semester remain graded P/NR with a 54-unit credit limit.

2) Freshman second semester be graded A,B,C/NR, with a 57-unit credit limit.

3) Starting in the Sophomore year, a student may in any term designate (by Add Date) one subject to be graded P/NR, to a possible total of 5 subjects.

The P/NR option replaces the current Junior-Senior P/D/F option, and may be used for no more than one subject satisfying a General Institute Requirement and one subject satisfying a departmental requirement.✣

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From The Libraries

Information Skills for Today and Tomorrow

Ruth K. Seidman

Instruction in the use of libraries and information resources has always been important in higher education. In light of today's constantly changing and developing information technology, this activity is more crucial than ever. An MIT education must include information literacy – the ability to identify an information need and then find, analyze, and present that information.

In 1998, the Institute Task Force on Student Life and Learning emphasized that future developments in information technology will center around content rather than facilities and equipment, and recommended that the MIT Libraries should play a teaching role so that students will acquire lifelong skills in locating, filtering, evaluating, and using effectively the wealth of information available to them.

Student interest in library and information instruction was made clear by the spring 1998 Libraries' survey of MIT undergraduate and graduate students. The results of this survey indicated that 71% of the respondents would like to have instruction in finding information and using library resources. When asked what methods would be most useful, 63% were interested in instruction through library handouts and brochures, 62% through the library's Web site, 56% through online tutorials, 40% through individual instruction at the reference desk, 27% at workshops, 18% by appointment with a librarian, and 11% during regularly scheduled class time.

The MIT Libraries are actively working toward meeting these needs.

Collaboration with Faculty

As a result of the Libraries' Public Services Redefinition (described in this column in the May/June issue of *Faculty Newsletter*), earlier efforts in library instruction are being strengthened with new activities and the creation of an Instruction Committee, whose purpose is to educate the MIT community in the effective use of information. Toward this goal, the MIT Libraries seek to collaborate with faculty in the educational process.

In addition to course-related instruction, the Libraries utilize many methods to help students and other members of the MIT community learn to use information resources effectively. A variety of brochures are available at all library locations and guides may be accessed through the library Web page <http://libraries.mit.edu>.

Librarians are helping to meet educational objectives by teaching students important information literacy skills. Some of these skills include:

• knowing how to cite a source;

• knowing the most effective methods for searching the Internet and other databases;

• being aware of the difference between primary and secondary sources;

• knowing how to evaluate an information source in terms of how authoritative it is;

• being able to find data sources, such as chemical, physical, or social data;

• knowing where to go to find information in a particular discipline;

• being aware of the variety of information sources available from the MIT Libraries and beyond;

• understanding what plagiarism is and how to avoid it.

Library staff have collaborated successfully in recent years with faculty on a number of courses, including Introduction to Psychology and the Mechanical Engineering senior design lab. Working with faculty and teaching assistants, a librarian can:

• create a Web-based library research guide for a course or for a specific assignment;

• teach seminars on how to search a database;

• serve as a librarian liaison for the course;

• provide an e-mail discussion group for a course;

• provide office hours so that students can receive individualized assistance, especially when they are working on assigned papers or other projects;

• come to a lecture and provide a brief presentation or activity.

To discuss this further, faculty are encouraged to send e-mail to the Instruction Committee at <instruct-lib@mit.edu>, or to contact either of

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Information Skills for Today and Tomorrow

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the committee's co-convenors, Poping Lin, x3-9321, plin@mit.edu or Jennie Sandberg, x-9349, jssandbe@mit.edu.

In addition to course-related instruction, the Libraries utilize many methods to help students and other members of the MIT community learn to use information resources effectively. A variety of brochures are available at all library locations and guides may be accessed through the library Web page <http://libraries.mit.edu>. In addition, the Libraries offer orientation programs, special workshops, and individual instruction.

Orientation

Library staff participate in all of the Institute's orientation activities – for international students, undergraduates, and graduate students. Included are library tours, introductory materials on library services, and quick instruction on basic information retrieval strategies and skills.

This year the Libraries have been experimenting with new ways of presenting library orientation to incoming students. The MIT Freshman Exploration series included a local author reading in the Humanities Library, a treasure hunt in Science, and a Dewey Library information fair.

Using another medium, a ten-minute video spoof of the "X-Files" set within an MIT context, was written and produced by the MIT Libraries in collaboration with MIT Video Productions, in an attempt to combine information literacy with entertainment. The video was shown at several orientation events, on MIT Cable during orientation week, and has been mounted on the Web at <http://libraries.mit.edu/services/orientation-video.html>.

Workshops

The Libraries present workshops on mastering specific information skills. Some are offered during the fall and spring semesters, and many choices are available during IAP. Topics range from Barton, the online catalog; to specific databases such as *Arts & Humanities Citation Index*, *Lexis/Nexis*, *MEDLINE*, and *IEEE/IEE Electronic Library Online*; to the very popular Patent Searching Workshop. These workshops are announced on the library Web page and are publicized around the campus.

Individual Instruction

Students may request individualized instruction, usually taking 10 to 30 minutes. This can be initiated by a request at any Reference Desk or by making an appointment with a library subject specialist.

Future Plans for Interactive Web Tutorials

The Libraries are planning to develop a series of interactive Web tutorials to promote information literacy. An example of a topic is instruction in the effective use of various Web search engines. There will be several benefits from this approach. As shown once again by the results of the Libraries' 1998 student survey, different people have different learning styles. While some learn best by coming to the library or to a workshop, others learn the same skills more successfully through online study. Moreover, this type of instruction will be available any time, and any place with Web access, rather than during library staff hours or at the time of a specifically scheduled workshop. Finally, this methodology will make use of new media and new technologies. When this project is started, the Libraries will be seeking faculty input.

In this and other instructional projects, library staff are very interested in receiving comments, suggestions, and feedback on both current instructional activities and ideas for the future. We encourage faculty members to contact the Instruction Committee <instruct-lib@mit.edu>, or any of the librarians. We are eager to work with you to create ever-improved approaches to building our students' lifelong information skills.✥

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Delivery of Library Materials

As part of the ongoing efforts of the MIT Libraries' Public Services redefinition process, a Document Delivery Task Force is currently reviewing and assessing delivery services provided by the Libraries. The goal is to improve retrieval and delivery of books, articles and other materials to all MIT users, both on and off campus. The Task Force is looking for evaluative feedback on the services currently offered as well as for suggestions for new services. A survey is being distributed at library reference desks and is linked to Web request forms for delivery services. See <http://macfadden.mit.edu:9500/imps/docdel/> for more information on the Task Force and a link to the online survey.✥

Some Meditations On Knowing Too Much

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myself boarding to be ignorant of the fundamental principles of civil or aeronautical engineering. I may be naive, in my way, but not self-destructively so. But we should admit to ourselves that we operate in a hierarchy of information at the Institute, and we like to think that information can be used as a measure of wisdom as well. If "ignorance" is taken as a kind of imaginative originality, then maybe Stevens was right. But how painful it is for all of us (we got here, and stay here, by "knowing the answers," after all) to admit our own ignorance. Of course we ask our students to do it all the time, to move into areas about which they know little or nothing.

My contention is that as teachers we may well find honest (put heavy emphasis on that) and well-timed ignorance to be an asset indeed. Let me approach this apparent paradox by way of the short-story writer and novelist Eudora Welty, whose book, *Losing Battles*, tells the story of a large family gathering somewhere deep in the South, to celebrate a matriarch's 100th birthday. Over two summer days in the 1930s there is heroic eating and even more heroic talking. Not surprisingly, the celebration has its share of ghosts, one of the most prominent Miss Julia Mortimer, for years the local school teacher.

Almost everyone in the novel has experienced Miss Julia's pedagogy – not always comfortably or profitably. She remains a mystery to all of the celebrants, until one person suggests a key to the conundrum: "She reads books in the daytime." (I once heard Miss Welty read this section of the novel to a Harvard audience, in full pomposity gathered. When she ended with that line, it took some seconds for us to realize how deftly and thoroughly we had been skewered.) Miss Julia, in a letter written shortly before her death, laments a life of what she sees as failure: "All my life I've fought a hard war with ignorance. Except in those cases you can count off on your fingers, I lost every battle. Year in, year out, my [students] took up the cause of the other side and held the fort against me. . . . Mostly I lost, they won. But as long as I was still young, I always thought if I could marshal strength enough of body and spirit and push with it, every ounce, I could change the future."

Thankfully, few if any of us will need to teach under the nearly-missionary circumstances that faced Miss Julia; none of us here at MIT will encounter true and full-bodied ignorance on its own ground. (I used to think those "Stupid People at MIT" t-shirts were comical; now they make me angry. SPAMIT is, as you might say, a null set. I know – I've taught in a public school.)

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And at least on our better days we refrain from her imagery of warfare; but if we are honest we will admit there is at least an imagery of physical struggle that frames our daily work as teachers. Miss Julia goes further and further down this dark road, though, and from the faint hope of making a better world, she descends to a sense of Darwinian struggle. The novel as a whole proves she didn't do much to enlarge or deepen or enrich the minds of her students. But she did leave a mark: "She was pretty smart herself! She rammed a good deal down me, spelling, arithmetic – well, history's where she fell down . . . There's a heap of history I don't know . . .But she knew it all. She had it by heart." The fellow who offers this estimation bears an even more astounding mark of her impact: he always writes his name with a question mark afterwards. "Because she told you to?" someone asks. "Well, she told me not to," he replies.

Miss Julia, despite heroic effort, hard work under thankless circumstances,

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ability and, yes, sheer obstinacy, has (even if she has won a sort of legendary immortality, the Socrates or Louis Agassiz of her tiny corner of the universe; to which roster I must add the stiff-backed woman who tried mightily to teach me to diagram a sentence in the eighth grade) just never overcome the burden of her own knowledge. She failed, I think, largely because she knew too much, and was unabashed about piling it on the minds of her students.

Let me concoct a hypothetical instance from my own academic speciality. Imagine a student who has, probably with limited pleasure and even more limited comprehension, completed a first reading of Walden. Bravely, she/he admits to some confusion, and the teacher weighs in: Well, it will help if you keep in mind what stands behind the book – the kinds of things Thoreau had read. He was Ralph Waldo Emerson's neighbor and – in a way – student. So a lot of what he has to say is an elaboration of some of Emerson's more renowned lecture-essays, like "Self-reliance" and "The American Scholar." And even though Thoreau insisted he never left his home town, he loved to read travel books, so when he says, "I have traveled widely . . . in Concord," he is not only joking. He says he took only one book with him to the pond – Homer. And of course makes lots of references to what he could find of Eastern writing. Then there's Romantic poetry, especially Wordsworth. And maybe (although he said he never read novels) he had read *Robinson Crusoe*, too. All I'm trying to point out is that, in spite of his insistence on originality, much of the book he wrote is an imitation or echo of other books he may well expect his reader to recognize.

The teacher's remarks are accurate and would serve well enough in a survey of American literature, to open up the issue of what is new and what is old about Thoreau's book and perhaps even in American culture generally. I would suspect it is the sort of laying the groundwork we all do, frequently, in our various disciplines. But consider this "helpful" disquisition from the student's standpoint. Suddenly she/he feels rather a fool; look at how much she/he missed, how inadequate her/his preparation is. What has happened is that she/he has gotten the impression that you can't read anything until you have read everything. A less literary, but no less chilling (to me, at least), version of this was offered by one of my colleagues – "You can't have imagination without information." In rebuttal to which, I offer Albert Einstein's dictum: "Imagination is more important than knowledge."

And I suspect the motives of the instructor, as well (I verge on confession, here). Is he (I wrote the explication, so I will not play political-correctness games with the pronouns, for once) not in fact at some level maintaining his own sense of power? In a culture that is fundamentally a hierarchy of information, as I have argued MIT is, to know more data is to rank higher on the scale. And to demonstrate to the students how much you know is to remind them of where they stand in the local scheme of things, as well.

One modest personal anecdote – before I scaled the heights of academia sufficiently to win faculty status, and then tenure, at MIT, I spent eight surprisingly happy years teaching in a local public junior high school. One day I was doing what I thought was a superb job of explaining the workings of the Supreme Court. One fellow toward the back – I wonder what John Spaulding is doing, these days? – politely raised his hand and asked, "How many people are there on the Supreme Court?" My mind went blank. I knew it was an odd number, and could explain why this had to be the case, to allow resolution of cases. I knew where and how to find out the answer, and in fact pointed John toward the library, right then. But I simply didn't know the answer to a simple question. The class was shocked. It was my first year in the classroom, and I was terrified – surely I had lost all hope of "control" or "influence" or "respect." For the moment, I suspect I had. But I had gained something as well – a sense that my students and I were engaged in a communal enterprise, called "learning." Communal and continuous and subject to frequent refreshment, you might say.

Which is by way of moving from what we do wrong to the benefits we might hope for if we altered our approach. In the promotional matter in the *Course Guide* (check out the sections under the School of Science and of Engineering, some time. I did so only at the earnest behest of Dean Birgeneau) – what you find presented is something rather near that tired old "Star Trek" formulation – "to boldly go where no one has gone before." And of course that's how to get tenure,

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isn't it? This from the introductory matter for the School of Engineering: "Engineering is a creative profession concerned with developing and applying scientific knowledge and technology to meet societal needs." How bravely prospective that is, with its emphasis on creativity, development, and application, not on finding out what the professor knows already, from years ago. This from the same portion of the catalog about the School of Science: "Above all, science is elegant, beautiful, and mysterious; it ennobles the human spirit. It is a privilege, whether for a semester, four years, or a lifetime, to attempt to understand Nature at its most fundamental level." That is good, even inspiring prose; but does it represent the way we run our classrooms? Do we communicate the excitement of mystery and elegance, the tentativeness and acceptance of risk contained in that one word "attempt"? I doubt it, and it saddens me to admit it.

A teacher who has all the answers, always, does so little to make the student (who at best has some of the answers, sometimes) feel at home engaging in intellectual dialogue. Again I am not naive enough to think that we ought to spend all of our time in mutual bafflement; but I would argue that the class cannot either always meet on our ground. There ought to be time, each day, when the issue under consideration either has no immediately apparent solution, or so many possible solutions that the teacher's is no better than another person's in the room. It is at that point that the class becomes a community of inquiry, rather than a tedious, unidirectional information off-load.

We must be honest, as I said before, and ask open-ended questions that are truly open-ended. Our students are after all no fools, and they can read our body language and our tone of voice when we are playing some sort of "deduce what I want you to say" game.

It is highly unlikely that Miss Julia Mortimer had any time for open-ended questions. She may well have been as all-knowing as her students suspected. They can recall only one thing she couldn't do better than anyone else: milk a cow. That suggests to me that her class should have met, at least once in a while, in a barn. And I don't mean to be hard on Miss Julia – a brave and effective woman, much less of a failure at her vocation than she fears. But it is a telling point, I think, that she is remembered (and with a healthy dollop of affection, if with some fear mixed in) for what she knew, but her students can retrieve only snatches of the things she taught them. She mistook – and are we not victims of the same misapprehension? – the acquisition of data for true learning.

It is my own impression, after more years in the classroom than I sometimes like to admit, that the most memorable things do not occur there because someone (least of all the pedagogue) causes them, as because they just, sometimes almost miraculously, dawn. Of course teaching involves preparation, planning, classroom management. But in the end the credit is due the one who has mastered something new. If we as teachers always know it all by heart, we deprive ourselves of much of the joy and wonder of learning. And that joy, in the end, is ample repayment for the momentary discomfort of saying those short but significant words: "I don't know."

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I offer the following modest proposal: that we consider it one of the delicious perquisites of our pedagogy to take the opportunity to be taught by some of the brightest people in the known world, which is to say our students.

In memory of Chris Christiansen.✣

[John Hildebidle can be reached at jjhildeb@mit.edu]

What is Community?

Jeremy D. Sher '99
Member, Presidential Task Force on Student Life and Learning

In the philosophy of the Educational Triad, the Task Force on Student Life and Learning argues that the education that twenty-first century MIT students need is composed of three different and equally important elements: academics, research, and community. The Task Force goes on to say that while MIT has always accomplished the former two exceedingly well, we lag behind on community. However, the Institute currently lacks a strategic vision for what this community should be. Before further discussion can be fruitful, we need to agree on what we're talking about.

Why Define Community?

I am the first to agree that communication does not require explicit definition of every term. But in the case of a vague public goal like "community," agreeing on the results we want will help clarify our discussions of how to achieve them. Indeed, we court undesirable consequences by leaving the term undefined. I have often heard people use a cloudy, visionless notion of community as "something that we need more of." Some people welcome this way of speaking because it affords the illicit luxury of defining "community" in any way they like: a person or committee may argue for any idea by saying that it will "build community." Such statements are very clever when used to support a favorite idea, because their meaninglessness makes them unassailable.

Community, when conceived as "something that we need more of," quickly becomes defined as the result of anyone's pet preconceived idea. In proposing a definition for "community," and then presenting my own vision of what the MIT community should be, I also propose more broadly to judge ideas on the basis of a predetermined notion of what we want to get out of them – not the other way around. We should ask, "What is the community we want?" and then, "How do we get there?" We should not ask, "How can I define 'community' such that my favorite idea can be said to improve it?"

"Community," in what I believe is the Educational Triad sense, refers collectively to educational areas involving interpersonal interaction, learning how to manage that interaction better, and fostering interaction across traditional boundaries. Interpersonal interaction skills – including teamwork, leadership, multicultural awareness, conflict resolution, effective communication, and many others – are the areas in which MIT needs to build.

The Meaning of Community

"Community," in what I believe is the Educational Triad sense, refers collectively to educational areas involving interpersonal interaction, learning how to manage that interaction better, and fostering interaction across traditional boundaries. Interpersonal interaction skills – including teamwork, leadership, multicultural awareness, conflict resolution, effective communication, and many others – are the areas in which MIT needs to build. Community education should help students gain life experience at personal, social, subcommunity, and broad community levels. With a balanced Educational Triad, MIT will be able to move from the doldrums to the vanguard of educational innovation in the community.

There is significant overlap between community education and academic education, especially in areas like writing and speaking. I shall return to this overlap later; for now, let me emphasize that although it exists – just as it does between academics and research – community education constitutes a separate leg of the Triad in its own right. Implementing community education does not mean merely extending academic life by, say, holding recitations in the residences. It means recognizing that learning to interact is a vital element of a quality educational experience, and then acting to provide that whole experience at MIT.

A Vision for Community

What follows is my own vision for MIT community. I hope that it will meet with approval. Even if it doesn't, I hope MIT will adopt the strategy of working toward a clear vision rather than tactically shooting in the dark.

Imagine a strong, whole MIT community whose strength derives

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from the strength, vitality, and diversity of the subcommunities comprising it. Strong subcommunities have always been among the most cherished assets of nonacademic life at MIT; they include residential communities, the varied array of clubs and activities, and others. I propose that these strong subcommunities are a strength to build on, and that we can and should build from them to create a strong community of the whole MIT.

This vision challenges a misinformed and unconstructive view that has nevertheless been gaining popularity in some quarters: the idea that strengthening the whole-MIT community will require weakening the subcommunities. This view is unconstructive in that it will prevent us from using our strengths, and it is misinformed in that it steadfastly ignores evidence and experience to the contrary. In fact, counterexamples to this wrong view are all around us. Let me present a couple of familiar cases of where strong communities successfully maintain strong subcommunities.

I call my vision the "federal model" after a famously successful 223-year experiment in subcommunity-supported community, of which we are each a part. America is composed of strong subcommunities, marked by broad differences in culture: variations and innovations that make Massachusetts, Texas, Georgia, California, and Minnesota what they are. No one proposes to force Texans to move to New England in order to create a stronger America. Yet the first allegiance of Americans is to America itself – all of the states exist under the federal umbrella. The subcommunities are strong, and may help to define individual Americans personally, but those subcommunities are parts of America.

Strong subcommunities are not where MIT has gone wrong; in fact, they're about the only area in nonacademic life where MIT has gone right. But MIT needs to link the subcommunities more strongly to the Institute as a whole.

For a higher-education example, consider Yale. The Yale community is built up from residential subcommunities that are much stronger and more separate than MIT's have ever been. Yet they were Yale songs I grew up hearing down the long New Jersey Turnpike, as my father (an alumnus of Yale's Saybrook College) sang and tapped his foot on the accelerator. Yalies fondly remember Yale; it is "for God, for country, and for Yale" that they fondly wave the handkerchief as they sing the last line of their alma mater. And each of Yale's 12 residential colleges is about as strong a subcommunity as could possibly be.

Strong subcommunities are not where MIT has gone wrong; in fact, they're about the only area in nonacademic life where MIT has gone right. But MIT needs to link the subcommunities more strongly to the Institute as a whole. If subcommunities are seen and felt as part of MIT, then belonging to those subcommunities will mean belonging to MIT.

Attention, purse-string holders: this means supporting them at a level beyond the minimum for survival. Of course you can't solve a problem by just throwing money at it, but a strong MIT community does cost something. The primary reason, in my view, that the subcommunities are so disconnected from a sense of belonging, is that over several decades MIT has largely left them to fend for themselves. Student leaders today (and I have been one) put an altogether inordinate amount of time into begging for funds, dealing with poor facilities, compensating for an almost total lack of residence-based program offerings, and recovering emotionally from an Institute that pushes them hard in academics but does little to encourage them along the way, or to help them learn the life skills they know they need.

Everyone knows that the subcommunities we have are formally a part of MIT, so it ought to be a paradox that students feel great allegiance for them but much less for MIT. In fact, as we all know, it is no paradox. Given how MIT has treated the subcommunities, it isn't really any wonder.

The current administration deserves much credit for making incremental strides in this area. However, MIT will need to make a radical strategic shift if it is to move from laggard to leader in community education. Tactical improvements will help stanch the bleeding, but implemented alone they cannot constitute a cure. The cure for MIT's ailing community life must come from a clear idea of what has gone wrong, an agreed-upon vision of what would be right, and a serious, high-level commitment to get there.

To those who claim that strong subcommunities have failed, I reply that MIT has never really tried to use them. Perhaps it is time we did.✣

[Jeremy D. Sher can be reached at jdsher@mit.edu]

Academic Computing Resources for You and Your Students

Lee Ridgway

Academic Computing at MIT fosters and supports a rich environment to promote and support varied uses of information technology for teaching and learning. A robust infrastructure of facilities, systems, and services is in place to support a diverse spectrum of educational goals. For an overview and links to detailed information about Academic Computing, see <http://web.mit.edu/acs/>.

Resources for Faculty

Academic Computing maintains the following resources to help faculty and their assistants understand and implement educational technology in their courses.

People Who Can Help You

The Academic Computing Faculty Liaisons help faculty and other instructional staff use information technology in their teaching. They will help you:

- get started learning about electronic educational media, the Athena computing environment, and the campus network (MITnet);
- find appropriate software for your courses;
- write courseware;
- create multimedia and hypermedia materials, including course Web pages.

Their expertise supports the use of computers and other technologies in teaching, including use of the Web and other network-based applications.

You can contact the Faculty Liaisons in the following ways:

- Home page: <http://web.mit.edu/acs/fl>
- Offices: N42 lower level (211 Mass. Ave.)
- Phone: x3-0115
- E-mail: f_l@mit.edu

Print and Web Resources

A new brochure, *Educational Computing Resources at MIT*, was recently mailed to all faculty. It outlines a variety of resources available on campus. For a Web version see <http://web.mit.edu/acs/instr-comp.html>.

The *Electronic Teaching Toolkit* at <http://web.mit.edu/faculty/ett> contains links to electronic resources that can assist faculty in preparing and conducting classes.

The *Academic Web Page Creation Guide* at <http://web.mit.edu/acs/webguide/> was developed to assist faculty and TAs in creating course Web pages.

The Insider, published three times a year with news from Academic Computing for faculty and TAs, may be received on paper or viewed online at <http://web.mit.edu/acs/insider>.

Other Activities and Initiatives

Crosstalk, a bimonthly forum sponsored by Academic Computing and the dean of Students and Undergraduate Education, brings together interested faculty for discussions, presentations, and feedback to Information Systems on a variety of topics. For more information see <http://web.mit.edu/acs/crosstalk.html>.

Proposals for support of educational computing initiatives may be submitted to Academic Computing. Details are available at <http://web.mit.edu/acs/guidelines.html>.

A new, Institute-wide Council on Educational Technology, chaired by the provost and another faculty member, will take up the issues identified in the 1997 report of a previous, similar council. It will consider new strategic directions, evaluate opportunities, and foster discussion of continuing programs.

The new Educational Media Creation Center, a collaboration between Academic Computing and CAES, has the goal of supporting the production of sustainable media- and Web-based educational materials. It will serve as a production and service unit for the Institute's broad, academically based initiatives to be distributed via the Web, television, and other systems.

Athena Clusters, Tools, and Software

The Athena system is a centrally managed, scalable, secure, campus-wide computing environment consisting of networked client workstations, servers, and printers available to MIT students and faculty to help them achieve their academic goals.

On campus, 17 general-purpose clusters house over 400 Unix workstations, while several departments and other facilities maintain their own clusters. Athena course tools include:

- electronic "course lockers" for storing course materials;
- electronic tools for delivering course materials, including Web pages, mailing lists, and conferencing systems;
- software for use by students and faculty in doing the actual work of the course;
- software for communication among students and between students and instructors;
- cross-cutting and specialized applications: FrameMaker, Matlab, Maple, Molecular Simulations, SAS, Tecplot, and Xess;
- standard compilers, Web browsers, communication tools.

For a comprehensive list of Athena software, see *What Runs Where* at

(Continued on next page)

Academic Computing Resources for You and Your Students

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<http://web.mit.edu/acs/whereruns.html>.

Classrooms and Other Facilities

Facilities for preparation and delivery of instructional technology include:

• three fully electronic classrooms, with an Athena workstation at each desk;

• thirteen classrooms with an instructor's Athena workstation and projector;

• over 25 classrooms with an MITnet drop and projection for a carry-in computer;

• over 60 additional classrooms with an MITnet drop;

• two New Media Center facilities for teaching and for the creation of multimedia.

For information on electronic classroom locations, equipment, and reservations, see <http://web.mit.edu/acs/eclassrooms.html>.

For information about the New Media Center facilities, see <http://web.mit.edu/nmc>.

Resources for Students

To help MIT students use Athena successfully, Information Systems offers a comprehensive series of "minicourses" on a variety of Athena-related topics. These courses are scheduled frequently throughout the academic year.

During Orientation week, incoming freshman, graduate, and transfer students had the opportunity to attend four basic courses:

Athena: The First Course
Working on Athena: Files and Unix
Word-Processing Options
Math Software Overview

By offering these courses before classes start, new MIT students can become familiar with Athena before they receive their first problem sets and paper assignments.

During the year, IS schedules minicourses for all levels of users. Minicourses are held the first six weeks of each semester, the week after Thanksgiving and spring break, and during IAP. Days and times are Monday through Thursday at noon, 7 pm, and 8 pm. All sessions are in Room 3-343. No registration is necessary and minicourses are free.

We encourage you to remind your students to take advantage of this excellent opportunity to learn more about the computer system that will be part of their MIT experience.

Below is a listing and brief description of the minicourses. The two basic courses, Athena: The First Course, and Working on Athena, are suggested as prerequisites for the other courses. [See next page for fall 1999 schedule.] Current and future schedules, and contact information for the Athena Training Group, are available at <http://web.mit.edu/minidev>.

Athena Minicourses

Athena: The First Course (First Course)
An introduction to the Athena academic computing environment: what you can do on Athena, your account, finding help, and other basics. Also includes E-mail, Zephyr, WebSIS, and Residential Computing.
Suggested prerequisite: None

Working on Athena: Files and Unix (Working)
Just the basics: files, directories, setting permissions, job control, and more. What every new user should know about Unix, Athena's operating system.
Suggested prerequisite: First Course

Word Processing Options (WPO)
A survey of the text-editing and word-processing packages available on Athena: FrameMaker, Latex, EZ, Emacs. Pick the right tool for the right job.

Advanced Word Processing: EZ (EZ)
Introduction to EZ, a combination text editor and formatter, with text-editing commands that are similar to Emacs. As a formatter, it is menu-driven and easy to learn, in the popular style of the "What You See Is (pretty much) What You Get" packages.

Advanced Word Processing: FrameMaker (Frame)
FrameMaker is a powerful word-processing and document preparation package now available on Athena.

Advanced Word Processing: LATEX (Latex)
An introduction to Latex, a widely-used text formatter, used for converting a text file into an attractive, professional-looking document. It is a powerful and flexible program, with capability to typeset many foreign characters and complex mathematical text.

Serious Emacs (SerEmacs)
The text editor introduced in Basic Word Processing has many useful features not covered in that course. This course is a must for anyone who uses Emacs more than an hour or two each week.
Suggested prerequisites: Emacs on-line tutorial, some Emacs experience

FrameMaker for Your Thesis (FrameThs)
FrameMaker, with a special template, can be used to produce an MIT thesis that meets all Institute formatting requirements.
Suggested prerequisites: Frame, some FrameMaker experience

Latex Thesis (LatexThs)
Using the Latex text formatter to produce a fully-featured thesis that meets all MIT format requirements.
Suggested prerequisites: Latex, some Latex experience

(Continued on next page)

Academic Computing Resources for You and Your Students

Ridgway, from preceding page

Math Software Overview (MSO)
A survey of major mathematics and graphing packages available on Athena.

Matlab (Matlab)
An interactive program for scientific and engineering numeric calculation. Applications include: matrix manipulation, digital signal processing, and 3-dimensional graphics.

Maple (Maple)
A mathematics program that can perform numerical and symbolic calculations, including formal and numerical integration, solving algebraic or transcendental systems and differential equations, and series expansion and matrix manipulation. It also has extensive graphics capabilities.

Xess (Xess)
A powerful and easy-to-learn spreadsheet, with a full range of mathematical, statistical, matrix, and string functions. It will be useful for scientific and engineering computations, as well as to general and financial users.

Information Resources on Athena (Info Res)
A survey of the communications, help, and other resources available on Athena.

HTML – Making a WWW Home Page (HTML)
Covers the basic features of HTML (Hyper-Text Mark-up Language), the language of the World Wide Web, as well as the steps needed to post your own Web page on Athena.

Customization on Athena (Dotfiles)
Intended for the intermediate-level Athena user, this course will discuss the Athena login sequence and the user-configuration files (dotfiles) that affect it, as well as changes users can make to those and other files to customize their working environment. Suggested prerequisites: some Athena (or other X Windows) experience

Athena® is a registered trademark of the Massachusetts Institute of Technology.✥

[Lee Ridgway can be reached at ridgway@mit.edu]

Athena Minicourses

	Mon		Tue		Wed		Thurs	
noon	Sept 13	Matlab	Sept 14	Matlab	Sept 15	Maple	Sept 16	Xess
7pm		MSO		MSO		Maple		Maple
8pm		Matlab		Matlab		Xess		Xess
noon	Sept 20	InfoRes	Sept 21	HTML	Sept 22	SerEmacs	Sept 23	Dotfiles
7pm		InfoRes		InfoRes		SerEmacs		SerEmacs
8pm		HTML		HTML		Dotfiles		Dotfiles
noon	Sept 27	First	Sept 28	Working	Sept 29	WPO	Sept 30	EZ
7pm		First		First		WPO		Wpo
8pm		Working		Working		EZ		EZ
noon	Oct 4	Frame	Oct 5	FrameThs	Oct 6	Latex	Oct 7	LatexThs
7pm		Frame		Frame		FrameThs		FrameThs
8pm		Latex		Latex		LatexThs		LatexThs
noon	Oct 11	Holiday	Oct 12	First	Oct 13	Working	Oct 14	WPO
7pm		No class		First		First		WPO
8pm				Working		Working		MSO
noon	Oct 18	Dotfiles	Oct 19	SerEmacs	Oct 20	HTML	Oct 21	Matlab
7pm		Dotfiles		Dotfiles		HTML		HTML
8pm		SerEmacs		SerEmacs		Matlab		Matlab

Alumni Travel Program Honors Faculty Offers Travel Opportunities

Melissa Chapman

The MIT Alumni Travel Program experienced a record-breaking year, servicing 631 alumni and guests in FY99. The popularity of the Alumni Travel Program is growing – much of this success is due to the involvement of MIT faculty members.

The MIT Alumni Travel Program is pleased to honor the following faculty members who have dedicated their time and effort to alumni trips over the years. Thank you for your hard work in making the MIT Alumni Travel Program a success: Dr. James Bellingham, Dr. Samuel Bowring, Dr. Bill Brace, Dr. John Edmond, Dr. Ernst Frankel, Dr. Mary Fuller, Dr. Donald Harleman, Dr. Ellen Harris, Professor Jay Keyser, Professor Thomas Mahoney (deceased), Dr. Charles Mazel, Professor Peter Perdue, Professor Lucian Pye, Dr. Harald Reiche (deceased), Dr. Margery Resnick, Dr. Eugene Skolnikoff, Dr. Robert Whitman, Dr. Elizabeth Wood.

This past summer, Professor Wood, of the department of History, led her first alumni program, which began in Prague and ended in Berlin. Of her experience, she comments, "I traveled this past June on a program from Prague to Berlin with the MIT alumni. The alumni were superb traveling companions – they were very curious and enthusiastic, and we engaged in many interesting discussions throughout the trip. I found the experience to be very rewarding and enjoyable. When the trip concluded, I extended my stay to conduct some research, which was a nice advantage as well."

"The two MIT alumni trips I led this year and last year to Hawaii and Iceland were a special opportunity to visit scenic places and to meet old friends," comments MIT Professor Bill Brace of the Earth, Atmospheric and Planetary Sciences Department. "Old classmates of mine participated on both trips. Being a geologist I had selected trips which featured volcanoes or glaciers. It was great fun to point out some of their interesting features and to bring people up to date on exciting new scientific work going on in these places."

Travel/lecture opportunities are open for the 2000 calendar year for MIT faculty members. There are openings in the following trips: *The Baltic Sea Countries*, June 4 – 17; *Montana by Rail*, June 21 – 29; *Russia's White Sea*, June 27 – July 11; *Paris and the Mediterranean to Rome*, July 10 – 13; *Family Program to the Galapagos*, July 15 – 25; *China and the Yangtse River*, September 26 – October 13; *Japan*, September 25 – October 6, 2000.

How do I find out more?

Please contact me to get more information. I can be reached at <mchapman@mit.edu>, 253-8265, or by fax: 258-6211.✥

MIT alumni travelers at the Instituto Internacional in Madrid, Spain.

SAP Upgrade Planned for November

Janet Snover

As you may have heard, MIT plans to upgrade our financial management software, SAP, to a new release in November 1999. The primary reason is to take advantage of technical improvements in the software. In addition, the new release will position MIT to ultimately move more functions onto the Web.

One reason for MIT's original decision to purchase a commercial package rather than doing our own development was the advantage of having access to improvements in the software, such as additional functions and increased operating speed, as they become available. MIT is currently on release 3.0 of SAP, and over the Veterans' Day weekend (November 11-14) we will upgrade the servers to SAP release 4.5. Please note that the SAP environment, including SAPweb, will not be available during the switchover. The Procurement Department will issue suggestions about ways to purchase emergency supplies during that weekend.

People who use the SAP GUI (graphical user interface) have been downloading it onto their desktops since it became available earlier in the fall. (The 4.5 GUI is backward compatible, so it will work with the 3.0 server version of SAP that MIT is currently running.)

The upgrade will provide both performance improvements, such as speeding the operation of the system, and maintenance utilities that will allow operations staff to do their work more quickly and accurately. The upgrade also will allow MIT to consider using new SAP functions, such as its travel process. Currently, our travel system uses customized code that was written at MIT. By taking advantage of SAP standard software in place of custom code, MIT can save maintenance costs, provide a more stable system, and reap the benefits of enhancements that SAP makes over time.

GUI users will see some minor differences between our current release and the new one, but there will be no changes for SAPweb users at MIT. Although fewer than 10 faculty members are regular users of the GUI, many of you supervise employees who use it in their work. Since the changes in the new release are minor, training is optional. Financial Systems Services (FSS) has recommended, however, that GUI users attend a one-hour demonstration to see the differences. Then they can decide if they need to sign up for training. (Users have received information about the dates and times for the demonstrations, as well as which computer platform – PC or Mac – will be shown.)

About 800 people at MIT use SAPweb exclusively and about 1,300 people use the GUI. (SAPweb also is used by 550 of the GUI users for purchasing transactions.) Approximately three-quarters of the 1,300 GUI users work in the departments, labs, and centers of MIT, and the other one-quarter work in central areas, such as the Controller's Accounting Office, Procurement, Facilities, etc.

There have been a number of SAP releases since 3.0, and the more releases that we skip, the more changes we will have to absorb in order to do an upgrade. In the future, we expect that periodic upgrades will be part of the normal course of events at MIT. However, the timing of upgrades and the communication about them will be carefully considered by the Administrative Systems and Policies Coordinating Council (ASPCC).

ASPCC was formed by Executive Vice President John R. Curry to review proposed administrative changes and to ensure that they are introduced in a coordinated and appropriately paced manner. I believe that one of the many lessons learned from MIT's Reengineering project was the importance of pacing changes so that members of the community don't feel overwhelmed. We didn't do a very good job of that during Reengineering, but we're trying hard to get it right as we go forward.

I'm a member of ASPCC and recently told the rest of the group that my alternative name for it is: the Administrative Society for the Prevention of Cruelty to the Community. They laughed, but there's some truth in that name.

And even though we don't expect that end users will have difficulty with the new SAP release, ASPCC also has been involved in reviewing the support services for the upgrade. For example, staff members in Financial Systems Services (FSS) and Information Systems (IS) are playing key roles in helping SAP users during the upgrade. The School Coordinators in FSS, who are assigned to specific areas, visit them regularly and also meet with the assistant dean and the administrative officers. The Business Liaison Team in IS assists SAP users who are downloading the GUI onto their desktops and also helps with questions about the new software.

In addition, there has been a lot of communication about the SAP upgrade – perhaps even more than was necessary, given the minimal changes to end users. There have been presentations, e-mail announcements, articles, and information on the Web. If you have suggestions about how we can improve an upgrade process even more in the future, I'd love to hear them.✣

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M.I.T. Numbers

Interesting Facts About the MIT Class of 2003 (1040 students)

Academic Distinction:

Type	# enrolling	% of class
SAT performance:		
at least 1 800	541	52%
at least 2 800s	299	29%
at least 3 800s	125	12%
at least 4 800s	44	4%
all 5 800s	16	2%
800/800	43	4%
members of US Olympiad Teams (Math, Physics, Chem., Bio, Infomatics):	7	1%
Gold/Silver medals in int'l comp.:	35	3%
Intel Science Fair Winners:	2	—-
Intel finalists:	6	1%
Research Science Institute:	18	2%

Extracurricular Distinction:

Arts (music, theatre, etc.):	708	68%
Athletics:		
Varsity:	566	54%
state/nat'l:	148	14%
Student government:	142	14%
Community Service:	446	43%
Leadership (holding highest leadership positions in any activity):	751	72%

Other Interesting Facts:

# of states represented in the class:	49 (no WY)
# of countries represented in the class:	50
# of languages spoken in homes of freshmen:	65
# of high schools represented in the class:	815
# of freshmen who did NOT do a co-curricular activity (math, science, technology related activity) in their last two years of high school:	30
# of enrolling students who own their own business:	18
# of students who were employed during their last two years of school:	323

Source: MIT Admissions Office