The MIT Faculty Newsletter

Annals of Reengineering

*I*n *a continuing attempt to keep the faculty abreast of issues involving Reengineering at MIT, the Faculty Newsletter is introducing a new regular feature. Annals of Reengineering will present commentary, updates, Q&A – a compendium of solicited and unsolicited material related to the ongoing Reengineering process. The success of this feature will rely to a large extent on the unsolicited contributions: We welcome and encourage input from the faculty as well as other members of the MIT community.*

SAP Takes Flight

John Hynes and Robert Murray

Writing about MIT's implementation of SAP at this point is a little like submitting a trip report before even arriving at the destination. Although SAP became the financial system of record on September 3, 1996, we are still only at the beginning of this journey. All of the work that has gone on over the past two years is analogous to trip planning and to preparing the aircraft. We are now on board and have just taken off.

We are on a voyage of experimentation and discovery. The Management Reporting and Financial Operations (MR/FO) Project started this adventure on August 12, 1994 when it was given the task of simplifying financial tracking and reporting for central and departmental offices across campus. The goal was to provide accurate information to faculty and staff members in a timely, efficient fashion. It was evident early in the process that in order to have a system flexible enough to incorporate individual departmental needs, and integrated enough to produce general Institute reports, it would be necessary to replace some key components of MIT's current financial system.

Reengineering the Customer

Richard Lanza

Under the pressure of severe budgetary constraints, it is often necessary to outsource services in order to preserve the central core functions of organizations. The primary question: which services to outsource? In the context of Reengineering at MIT, which services are unique to the Institute (helping to define its character and function) and which are amenable to outsourcing? Unfortunately, the decision-making process at MIT often appears to many to have had a bias toward centralizing functions in the interest of "improved efficiency" with little or no consideration given to maintaining the Institute's character and function, and with no concern for customer convenience or other potential alternatives. (All of which begs the question of the initial Reengineering decision to outsource the intellectual component of the project – $6.5 million to CSC Index for a reengineering "model" in lieu of taking advantage of the expertise inherent in the Sloan School.)

As was pointed out in an earlier *Faculty Newsletter* ("Penny Wise and Pound Foolish: Re-Engineering Reengineering,"

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Editorial

It's Your Turn

It's a new academic year and the graduating class of 2000 is officially enrolled. The coming year likely holds many topics of interest and concern to the MIT faculty (e.g., see From The Faculty Chair, Page 4). Questions of federal and non-governmental financial support, overhead rates, graduate student support and others are of concern to us all. Administration (and faculty) discussions are ongoing with the federal government in Washington, and we would like to commend the MIT administration in their handling of some very difficult and complicated negotiations in these areas.

The *MIT Faculty Newsletter* plans to continue to provide as wide a range of information and opinions from and to the MIT faculty as possible. But we can't do it alone. We need the support of the MIT faculty to continue producing a quality and varied *Newsletter*. And there are two ways in which you can show your support.

1) Write. A majority of the pieces in each issue are requested by the Editorial Committee for that issue; the rest are volunteered. We need more volunteering. (Particularly from junior faculty!)

2) Join the *Faculty Newsletter* Editorial Board. This is a voluntary nobody-is-turned-down operation. The more schools represented on the Editorial Board, the greater the potential variety of editorial input. And the less work for the rest of us. A notice will be appearing in the *Newsletter* for the forthcoming Editorial Board meeting. Why not consider participating? Please contact any member of the Editorial Board (list on Page 2) if you'd like to join.

World Wide Web Update

Plans continue for a *Faculty Newsletter* Home Page on the Web and for a faculty-based electronic bulletin board. Negotiations with the MIT administration for financial and logistic support bogged down last spring, and despite attempts to resolve the issues over the summer, scant progress has been made. *Newsletter* Editorial Board members handling the negotiations are optimistic that resolution will occur shortly, and that after discussions with the Faculty Policy Committee (as agreed to last April) an electronic version of the *Newsletter* will appear shortly. Again, there are no plans to replace the current printed version.

As requested in the last *Faculty Newsletter* (*Editorial*, Vol. VIII No. 4) we have received some comments regarding a Web presence [see Letters, Page 23]. We are still hoping for further input from the faculty regarding the proposed home page and the electronic bulletin board.

Annals of Reengineering

With this issue of the *Newsletter* we introduce a continuing feature, Annals of Reengineering. Articles concerning Reengineering at MIT appear on Page 1, "SAP Takes Flight" and "Reengineering the Customer", and Page 10, "Making Student Services Better." We plan to continue providing updates and information concerning Reengineering throughout the year.

In order for this new feature to succeed, it will be necessary for us to receive facts, comments, articles, etc. from as many sources around the Institute as possible. So if you have had a particularly interesting/frustrating/exciting experience with Reengineering, or if you'd simply like to write an opinion piece, we look forward to hearing from you. Our staff is simply too small to access all the nooks and crannies of MIT to discover the varied experiences and responses to Reengineering.

We encourage submissions concerning Reengineering or any topic of interest to the MIT faculty and community. We can be reached by e-mail: fnl@mit.edu; FAX: 253-0458; telephone: 253-7303; or mail: 38-160.

Editorial Committee

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Facts About Our Freshmen

Undergraduate Academic Affairs

- 1071 individuals
- 80% U.S. Citizens
- 12% Permanent Residents
- 8% International Citizens
- 29% from homes where English isn't the first language
- 58% men
- 42% women

- 27% Asian-Americans
- 17% Underrepresented Minorities
- 21% from high schools with graduating classes under 100
- 66% (50% of the men, 90% of the women) in residence halls on campus
- 34% (50% of the men, 20% of the women) in fraternities, sororities, or

other small independent living groups on and off campus
- 33% (38% of the men, 23% of the women) in single-sex residences
- 67% (62% of the men, 77% of the women) in mixed-sex residences
- Housing integrates freshmen/upperclass students (freshmen not segregated)

From The Faculty Chair

The Year Ahead . . .

Lawrence S. Bacow

The fall term seemed to sneak up much faster than usual this year. I am not sure if the summer seemed short because it was so cool, or because I found myself dealing with so many administrative responsibilities during time usually reserved for scholarship. When I mentioned my "short" summer to colleagues around the Institute, many voiced similar sentiments. For a variety of reasons, the rhythm of academic life seems to be changing. The pace of the summer has quickened, the pressures of the year have increased, and in the words of Sloan's Tom Kochan, the autonomy and flexibility that are one of the great attractions of academic life often seem to be in short supply.

Many explanations account for these changes. Most are not unique to MIT. Research funds are scarce, so more time is spent writing proposals and trying to stretch existing resources. Many of us are working in two-career families. Juggling kids, household, and professional responsibilities is no longer just a women's issue. Athough technology has made us more efficient, it is also eroding the boundaries between work and leisure. Work is never farther away than the ubiquitous laptop. With e-mail and voice mail, we rarely escape the crisis of the moment. More of us are teaching during IAP and the summer as academic programs expand and the year is compressed. Budgetary exigencies have produced belt tightening, and reduced the

flexibility previously enjoyed by anyone responsible for managing a budget. Much of the time we used to spend nurturing new initiatives has given way to protecting existing activities. Reengineering is starting to directly affect the life of the faculty,

> Last spring, 79 of our colleagues opted for the retirement incentive program. Collectively, they represent 2,817 years of service to the Institute. While it will not be easy to replace their wisdom and experience, their retirement represents a historic opportunity for the Institute. Over the next several years, we have a chance to create critical mass in new areas of inquiry and scholarship.

as the work of those who support us is restructured. Familiar routines are being changed, and familiar faces are departing.

Last week, the Faculty Policy Committee (FPC) met for the first time this year. We agreed that faculty quality of life should be high on our agenda in the year ahead. In a few weeks, we will review the survey done last year on faculty attitudes towards their work. I look forward to sharing our discussions with you in a future column.

A number of items are likely to command the attention of the faculty this year.

Last spring, 79 of our colleagues opted for the retirement incentive program. Collectively, they represent

2,817 years of service to the Institute. While it will not be easy to replace their wisdom and experience, their retirement represents a historic opportunity for the Institute. Over the next several years, we have a chance to create critical mass in new areas of inquiry and scholarship. Because of the scale of the retirements (over ten percent of the tenured faculty) we are unlikely to have a comparable opportunity for years. Now is the time to ask, "Which areas of intellectual endeavor merit additional investments in new faculty?" No doubt, these decisions will spark vigorous debate both within and across departments. However, we will make no more important decision as a faculty in the foreseeable future. These appointments will shape our future intellectual agenda, and define the ranks of our future leadership. We must make these decisions wisely and strategically.

The Year Ahead . . .
Bacow, from preceding page

One particular appointment merits special attention. At the Corporation meeting preceding graduation, Paul Gray announced he would be stepping down as chairman of the Corporation effective June 30, 1997. Paul will be returning to the ranks of the faculty in Course Six. We welcome him back. While the choice of a new Corporation Chair falls within the exclusive province of the Corporation, we as a faculty are not without interest in this decision.

Unlike most other universities, our Chairman of the Board of Trustees has always been an academic. In fact, with the exception of Jerry Weisner, the immediate past President of the Institute has always assumed the Chairmanship of the Corporation. This tradition of elevating the President to Corporation Chair has provided stability and continuity. Moreover, it has also contributed to an unusual degree of cooperation and understanding between the faculty and the Corporation. Unlike many other universities, we have avoided major struggles between the faculty and the Trustees. However, because President Vest is not yet ready to assume the Chairmanship, it is likely that we will have a different kind of Corporation Chair come June 30, one that may be elected from the ranks of the membership, and who might serve on a part-time basis.

This summer, the Faculty Policy Committee met with Dr. Gerald Austin, chairman of the search committee seeking a successor to Paul. We discussed both the process for selecting a new Corporation Chair, as well as the need to consider new models for the position. The conversation was very productive. The faculty described the qualities they believed desirable in a new Corporation Chair – most specifically, a thorough understanding of MIT, an appreciation of scholarly values, and experience in resource development. We also discussed the importance of

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the position to the faculty. Most of us left the meeting persuaded that, given the right person, a number of models of a Corporation Chair could be made to work.

Two other items are certain to come before the full faculty this year.

The Department of Earth, Atmospheric and Planetary Sciences is proposing a new one-year Master of Sciences Degree in Geosystems. What makes this proposal unique is that it is the first professional masters degree to be offered within the School of Science. The degree is intended to be a first professional degree for those seeking careers in the geoscience industry. Other than originating in the School of Science, the degree follows the pattern of other professional masters programs approved by the faculty in the past few years. The FPC endorsed the proposal enthusiastically last spring, and it will be presented to the faculty at the October meeting.

The Committee on the Writing Requirement, under the leadership of Kip Hodges, Alan Lightman, and Les Perelman, has been working for more than two years on reformulating the Institute writing requirement. According to the Committee, the current requirement is seen by students as more of a hurdle to be cleared rather than an educational experience that promotes good writing. Building on a series of pilot programs in the School of Engineering, the Committee is developing a new requirement that promotes written and oral communication skills through a series of communications-intensive subjects. Many of these subjects would be taught within a student's major. The reformulated requirement should reach the faculty for a vote next spring. ✤

SAP Takes Flight
Hynes and Murray, from Page 1

Selecting SAP

The software package chosen to meet MIT's reporting needs was SAP R/3, developed by the German-based company SAP AG. (SAP is an acronym for "Systems, Applications, and Products in Data Processing.") SAP is used by major corporations in more than 50 countries, including half of the "Fortune 500" companies in the United States. MIT will be the first institution of higher learning in the United States to install SAP. Duke University, and the Duke University Medical School, recently decided to use SAP as their primary information system.

Central financial and purchasing offices began using SAP on September 3 following job-specific training classes held during July and August. Departments, labs, and centers will start to use the SAP software school-by-school beginning in November, with all schools on-line by June 1997. In the future we will be providing successive releases of the product with enhanced functionality and reporting features specifically configured for MIT by the MR/FO project. We will also take advantage of any future releases from SAP AG.

In some respects, the most important feature of the initial implementation of

begin with a description of the end-state (where we are going), then say a few words about what we are leaving behind, and finally talk about the progress to date – where we are at takeoff and how we expect our financial work to be different now that we are airborne.

Management Systems: *Common standards and real-time information*

A key feature of SAP is that it will bring real-time financial information to MIT through a common graphical user interface that provides a similar look and feel on the principal computer platforms in use at the Institute (Mac, Windows, and UNIX). Since our new online system is an integrated package, it eliminates a great deal of needless data re-entry. The use of a set of common management tools across the Institute will, in time, result in a pool of SAP-knowledgeable MIT staff with the flexibility to fill departmental openings as they occur.

Over the years, MIT departments, laboratories, and centers have developed a Babel-like array of local systems to complement those of the central administration. Only by using these so-called "shadow systems," either on their own or together with central systems, were some departments able to manage their research, instruction, and community service activities. This solution often resulted in significant re-entry and reconciliation of data between central and shadow systems, and made it difficult to replace and train the staff who used these unique systems. In addition, these systems did not allow for the sharing of data electronically across departmental boundaries. The integrated and much more versatile structure of SAP will allow all users to obtain and share information through a single and commonly used SAP system.

The initial SAP implementation can be seen as having three major components.

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While SAP R/3 initially met most of MIT's business requirements, the funds management module did not support all of MIT's reporting requirements. These reporting requirements are shared by many large American universities and nonprofit organizations – a market SAP AG is trying to penetrate. Under their contract, MIT agreed to form a partnership with SAP. Part of that relationship will be to jointly develop enhancements for the Funds Management module. Some of these enhancements are included in the initial implementation of SAP at MIT. Others will result from the ongoing partnership, as well as from SAP's successful launch into this new market.

SAP is that it provides the base for subsequent releases. In other words, having achieved takeoff, we can proceed with the process of continuous improvement, which will be the ongoing mission of the Management Reporting and Financial Operations Team. But that's all about where we are eventually going – our destination – and that comes later. Right now we are still in flight.

In selecting a sample of financial management activities to highlight in this article, we've tried to choose those which would be of greatest interest to MIT faculty. We will address each of these activities in the same fashion. We'll

SAP Takes Flight
Hynes and Murray, from preceding page

These components are configuration, deployment, and training. A very significant portion of the preparation that has gone before this implementation phase has had to do with configuration, i.e., the process whereby the SAP system is customized to MIT's specific requirements. At first, that work was done exclusively by the MR/FO staff. More recently, through a number of Institute-wide Implementation Teams, a fairly broad segment of the MIT community has been involved. As of initial implementation, four MIT work processes had been configured in the SAP environment. They are: financial management, research management, plan and distribute labor costs, and the buy/pay process. The basic configuration of a fifth work process, planning and budgeting, is now underway. The configuration of all Institute work processes will continue to be enhanced and streamlined as we go forward.

Having MIT work processes configured in SAP is of little value if users can not access them. The Institute has a very diverse set of workstations running a variety of operating systems. One of the reasons that SAP is seen as a good solution for MIT is that there are versions of it available for Intel-based computers, Macs, and some UNIX workstations. MIT is also very diverse in the quality of its computing power. Some sites have state-of-the-art equipment and others rely on equipment that is several years old. SAP and other new business applications require up-to-date computing power including Ethernet connections to MITnet. One aspect of the initial implementation is to ensure that up-to-date environments exist across the Institute, so that the SAP user interface can be effectively deployed wherever it is needed.

For the initial SAP implementation, MIT has developed a comprehensive training program using the staff and facilities of the new MIT Professional Learning Center, the extensive experience of Documentation Associates, the

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resources of the World Wide Web, and a variety of other computer-based training and video training tools. The training program being used for initial implementation will continue to be available in the future to apply to new and enhanced functionality, new hires, and refresher courses.

Reporting: *Customization*

One of our reporting goals is to build links between SAP and other MIT information resources, like the data warehouse. Another longer-term goal is to introduce additional SAP components. Eventually, we would expect to see the use of 3D graphics, as well as voice and video annotation, to enhance our reporting capabilities.

Historically, financial information consumers at MIT have had to choose between relatively limited numbers of standard reports that were provided centrally, or had to re-enter central data in a departmental system in order to generate the reports that would meet their exact requirements. They often had to "cut and paste" to make centrally furnished information meaningful, or had to devote significant resources to support and maintain a departmental reporting capability.

Beginning with initial implementation, SAP will provide a flexible approach to departmental reporting by virtue of its being an integrated system. The foundation of SAP is a relational database that brings together data previously stored in separate MIT systems. The SAP design allows an appropriately authorized user to access all available data fields and to create customized reports in a wide variety of ways, utilizing both text and graphics. The user can view a report on a computer screen, print it locally, or use the report data in another local application.

Account Structures: *Unlimited Hierarchies*

SAP provides unlimited numbers of accounts, or cost objects (as they are known in SAP). This will allow organizational units to design the kinds of financial architectures and cost object hierarchies that will best serve their individual requirements. SAP also provides unlimited levels of "parent" and "child" account relationships, including grandchildren and great-grandchildren level hierarchies. This will permit a program director to establish multiple tasks or activities for each of several investigators in multi-investigator programs, like program-project grants or consortia-funded programs. SAP also provides the ability to group tasks of departments, labs, and

SAP Takes Flight
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centers into alternative hierarchies in order to generate activity views or program views of these tasks.

In the past, a shortage of account numbers and restrictions in account number ranges have artificially constrained the financial architectures that departments, labs, and centers have employed to manage their activities. This resulted in the creation of a number of work-around solutions, including some that distorted Institute-level reporting – like using object codes in ways that are completely unrelated to the object code name and intended purpose.

Some of the benefits of these new account structures will not be realized until all of MIT has been converted to SAP, which is estimated to be finished by July 1, 1997. Until then, mapping SAP to the existing system will enforce some of the existing system's limitations. Once the existing accounting systems have been turned off and the requirement to map to those systems is eliminated, we will be able to more fully exploit the rich functionality of SAP.

Purchasing and Accounting:
Integration of Commitments

One of the most beneficial features of our new system is that eventually uncommitted account balances will be instantly reduced to reflect both the direct and the indirect costs associated with a requisition that has been issued in SAP. In other words, one of the most obvious advantages of SAP is that it fully integrates the purchasing and financial reporting processes.

(Two features that complement the integration found in SAP are the abilities to search and drill-down. A user can search for and instantly determine the creator and/or the status of requisitions, purchase orders, and journal vouchers as they move through MIT approval channels. With appropriate author-ization, a user can also drill-down to the

Labor Distribution System (LDS) to view names, salary, employee benefits, overhead, lab allocations, and the percent of effort on a project.)

Previously, MIT's central systems were unable to automatically reserve funds from the budgets against which requisitions and purchase orders were being processed. Uncommitted balances were not reduced until month end to reflect both the direct and the indirect costs represented by purchase orders.

At initial implementation, uncom-mitted account balances in SAP will be instantly reduced to reflect the *direct costs* associated with a requisition. Uncommitted account balances will be reduced overnight to reflect the *indirect costs* applicable to the requisitions issued during the preceding day. Eventually, it is anticipated that the full effect of a requisition will be instantly applied.

Plan and Distribute Labor Costs:
Commitments, What-Ifs, and Proposal Personnel Budgets

SAP and MIT will be working together to assess whether the SAP Human Resource Module may be developed to include the ability to record current and future salary commitments by cost object. The goal is to integrate the Institute's payroll, benefits, and personnel functions to permit users to manage all the tasks associated with labor planning and management.

The Institute has never had a consistent mechanism to record current and future salary commitments. The need for this capability is one of the forces that has brought about the development of shadow systems.

For the current implementation, MIT has developed an interim Labor Distribution System. It appears as a menu choice in SAP, and provides an integrated tool that enables managers to plan, budget, track, and report labor costs and effort distribution. LDS includes the

ability to maintain appointments and distributions for which commitments (with benefits, overhead, and allocations) will be calculated and posted to SAP in real time. It can be used to create "what-if" scenarios for current cost objects without changing actual or committed distributions. The LDS also allows managers to create proposal personnel budgets to be exported to local spreadsheet applications – and eventually to the OSP Electronic Proposal System.

Moving Forward

As indicated above, with the initial implementation of SAP we have achieved the baseline configuration of most of the MIT work processes. This is just a beginning – a point of departure. The goal now is to continue to improve SAP as a tool for Management Reporting and Financial Operations, so that it will address both the needs of the Institute and of the faculty for some time to come. In pursuit of this goal we are soliciting faculty comments and recommendations with respect to their desired improvements. Whether or not you ever expect to use it directly, SAP will significantly effect how your MIT business is done from now on.

If you have any comments or suggestions, please contact John Hynes of the MR/FO Project by phone at 258-6220, or by email at <hynes@mit.edu>. We will work with you to define your requirements and then determine if we can satisfy those requirements in SAP. In a future issue of the *Faculty Newsletter* we will report back to you on both what you proposed and on how we responded.

We look forward to your participation in this exciting effort. So fasten your seatbelt (there's likely to be some turbulence) and join us in this journey – at the end of which we will all be Managing Information for Tomorrow at MIT.✤

Reengineering the Customer

Vol. VIII No. 1) the costs of some improvement (e.g., centralizing mail services) may be hidden in the decreased productivity of the end users ("customers") who now have additional work to perform but whose cost is not directly counted in the cost of the new system. Also ignored is the fact that often the customer may very well be willing to pay a price for speed and convenience not offered by the centralized "partners" model; in this case the price being a reflection of how much the customer values his or her time. Such convenience establishments as *Store 24* and *7-Eleven* thrive on the basis of these two factors. As a further example, for many of my students the preferred partner for hardware is *Home Depot*, which offers a combination of long hours, good prices, instant delivery, small quantity purchases, and the ability to actually see the material before picking it up – virtues, incidentally, which were also present in the old Lab Supplies system.

A recent experience in my lab makes the point even closer to home: An o-ring in a vacuum system needed to be replaced. Since it was after 3 pm on Friday, ordering through our "partner" VWR Scientific would have resulted in Tuesday delivery, since the order could not have been entered until Monday morning. In the old "inefficient" Lab Supplies, my student would have brought the old one in, compared it to the stock o-rings, and been back in operation within an hour.

Since the customer is supposed to be the central figure in Total Quality Management (TQM) models in modern corporations (upon which MIT Reengineering is based), I propose that customers become part of Reengineering decisions and that their market choices drive Reengineering directions. A model for this may already exist in corporate America: the disappearance of the Central Research Lab with centralized funding in favor of a new approach in which researchers in the central lab now have to make their case for funding to the operating divisions and not just to upper level management. The idea is to ensure that research priorities are directed toward the needs of the end users. If a researcher can't get funding from operating divisions, presumably the "customer" for research, then the research is not relevant to them and shouldn't be funded. (A discussion of trade-off between short-term and long-term goals is, of course, the crux of criticism of this method, but then again, those issues have also been raised in the context of Reengineering.)

So, how would this work in practice and how would customers influence decisions? One model to start with would be in the allocation of overhead costs. Without getting to the micro level, perhaps researchers could see which services they use most and allocate more or less of their overhead money to that area. Perhaps they would choose to support Lab Supplies and technical facilities such as machine shops, rather than, say, Human Resources (nee Personnel). Perhaps they would trade the Personnel Office's training programs (see Page 15) for some of the journals that the libraries had to cut. Should I be able to mail letters directly or should I use the central facility?; should I use an in-house machine shop or an outside one?; should inside personnel services compete with outside recruiters?; etc. The point is not whether one service is better or worse than another, but simply to make Reengineering into what we want it to be, namely a way to allocate resources according to the desires and needs of the customer and to ensure that no operation is isolated from customer feedback. If a thorough analysis was undertaken, including both cost and convenience/need, some of the hidden costs for services which are taken for granted might become more apparent and significantly impact the decision-making process.

A further goal should be to preserve those facilities which are unique to MIT and cannot be easily outsourced or whose value may be more than the bottom line cost. For example, how do we determine the value of a machine shop filled with machinists with 30 or more years of experience, who are able to suggest improvements and changes to designs rather than simply following the drawings? There is a vast difference between 30 years' experience and 1 year's experience 30 times – none of which shows up in the direct cost but is certainly apparent to the customer. If the hoped-for results of Reengineering are as claimed (improved efficiency and not just cost cutting), then clearly services inside the Institute should be able to compete successfully with those outside, and must have the correct mixture of price, function, and convenience. If the inside services can not compete in all these areas, then they should be required to make a case for their share of the overhead money, by appealing to their customers in competition with other vendors, or they, too, should be outsourced.

It's not quite a survival of the fittest world in the Reengineered MIT, but there clearly needs to be some level of competition and response to the customer in order to prevent malaise and lack of innovation. Where is the motivation to change and improve without potential loss of customer support? Decentralization worked for the former customers of the once-monopoly AT&T. Given the significant amount of nationwide reconsideration about the basic value of TQM and reengineering, perhaps it is time to slow down some of the rush toward centralization, and consider the needs of the customers (faculty? students? staff?) a bit more. Then, perhaps, we will decide to outsource the outsourcers. ✥

Making Student Services Better

Martin F. Schlecht

It's been nearly a year since 18 of us (students, staff, and faculty) first gathered to "reengineer" the way MIT delivers student services. Since then, we and the many people who have joined us have made real progress, and more is on the way. What follows is a brief description of what we've done and where we are going.

When we started, we were unsure what reengineering was and had some doubt about its appropriateness for MIT, but we knew that significant improvements in student services were possible and necessary. With the support of our sponsors, the late James Culliton (vice-president for admini-stration) and Dean Rosalind Williams, and with the guidance of those who had done this kind of work before, we began a process of learning and change. Seeing the benefits so far, we are convinced that we have found a way to better serve our students and support the faculty.

Student services reengineering began with two closely collaborating teams. One focused on the processes that support students' financial transactions (for example, awarding financial aid and paying students for on-campus employment) and academic trans-actions (such as registering for classes and tracking degree progress). Its goal was to design ways to improve and more effectively deliver these services. The other team's purpose was to look at the rest of student services (such as career services, housing, and support for co-curricular activities) and to assess opportunities for future redesign efforts.

For both teams, the procedure was similar. We first learned to interact as a team – listening, setting priorities, and working together toward common goals. Then we engaged the MIT community (students, staff, and faculty – an estimated 1500 people in all) to learn what was being done well and what needed to be changed. The issues ranged from the specific processes, to the technical tools that support them, to the way we organize, manage, and train, and to the values that guide us. We heard many good ideas. Consolidating all that we learned, we made recommendations for how to proceed. Finally, we went back to the community and asked them to help us refine our ideas.

The next step was to implement the new design. To form the FAST (financial and academic services transition) team, we recruited more students and staff to work with us part time, many of the latter from the offices of Financial Aid, the Bursar, and the Registrar, as well as other staff in academic administration. The purpose

here was to draw on the knowledge and skills of the people who well understand both the problems and the virtues of our current services. We also drew on the expertise of outside consultants.

One overall FAST goal is to make it possible for students and staff to transact routine business (such as changing an address) and to answer routine questions (for example, has the Bursar's Office received a payment?)

> **Another goal is to establish a conveniently located Student Service Center where many needs can be handled in one place, even if they involve multiple transactions, such as paying a bill and picking up registration material. This, together with the new online services, will mean that students will no longer have to take long walks to administrative offices during classroom hours to resolve relatively routine problems.**

online. This way information will be readily accessible to those who need it, and it will be necessary to enter the data only once, at the source.

Another goal is to establish a conveniently located Student Service Center where many needs can be handled in one place, even if they involve multiple transactions, such as paying a bill and picking up registration material. This, together with the new online services, will mean that students will no longer have to take long walks to administrative offices during classroom hours to resolve relatively routine problems.

Making Student Services Better

A third goal is to organize those who deliver student services around the processes they perform. This will help us focus on the desired result: a satisfied (and maybe even happy) student, a better work environment for those delivering the services, and all at less cost.

Consider one specific example of a change that one of our FAST teams recently implemented. Staff in academic departments, laboratories, and centers used to process graduate student awards and appointments by filling out forms and sending copies to various offices (some of which no longer needed them and so threw them out). The information itself was entered into the computer system by the Graduate Education Office, an operation that created a funnel that couldn't help but slow the process down. If there was a problem – for example, a student didn't receive an expected stipend from the Payroll Office – an academic administrator would have to make several phone calls (to the Bursar's Office, the Payroll Office, the GEO) to see where things went wrong.

Meanwhile, the Student Financial Aid Office was busy arranging cash advances to the student, and the Bursar's Office was manually sheltering the student's account from finance charges in anticipation of the completed award. Furthermore, while the GEO was entering information online, the academic administrators were also maintaining their own data bases to be sure they had timely, accurate, and easily accessible records.

Now, as of September, the entire process is almost totally automated. The academic administrator enters online directly the data that used to be put down on paper forms. The appointment is effective within a day, and the Bursar's Office and the Payroll Office have all the information necessary to perform the proper transaction. If a question does arise, all the information needed to address it is online. Now we will focus on making this system tie in more smoothly with the various academic administrators' data bases so that redundant data entry can be avoided.

While the FAST team is going forward, several other teams are working on other areas of student services. This summer, a team created a new model for supporting students in their co-curricular activities (such as student groups, athletic events, and music and theater performances). Students made up half of this team, with Anthony Ives, a graduate student in the Department of Urban Studies and Planning, serving as captain. Members looked at how groups register with MIT, how they schedule space, how they plan events, how they receive funds and other resources from MIT, and how their accounts are managed. The team is now working with the community to refine its recommendations.

Another team is working to unify the way we operate student housing so that issues regarding the residential life experience and the management and maintenance of facilities are better coordinated.

This month a third team will begin working on the delivery of career services to our students (and alumni/ae). How we help students plan their ongoing education and careers, how we provide information about opportunities, how we help link students, staff, faculty, and potential employers are some of the issues its members will address.

In the near future we also intend to look at how we provide orientation (not rush) and personal support to our students.

Just a few final points. First, much of what we have called student services is provided by staff within the academic departments, laboratories, and centers. We are working closely with these people to support their efforts and make their interactions with the central services simpler. Second, much more information on student services reengineering is available in either written documents or on the Web. Our Web site is *<http://web.mit.edu/reeng/www/studentserve/>*. You can e-mail questions, suggestions, or feedback to studentserve@mit.edu.

And last, I would like to say that I'm very pleased and proud to be working with so many people who are devoted to making MIT the best it can be. They have embraced change, always a threatening thing to do, and have found a way to make it happen. They have also worked very hard to create a new way to deliver services while keeping the old system operating until the changeover is made. I hope you will join me in thanking them, and one of the best ways to do that is to learn what they are doing, and to ask them how you can help.✣

Coming Soon To An Institute Near You!

Crosstalk – A Forum for Technology, Teaching, and Learning

M. S. Vijay Kumar

Are there signs of intelligent life on the Internet? Is a picture really worth a thousand words? What do you do after you build it and they come?

Questions such as these have been the concern of those promoting and practicing the use of information technology (IT) for different educational ends. While some of these questions may have been answered or even become irrelevant at MIT, a range of issues around the technology-pedagogy connection are of increasing interest to faculty, given the ever expanding scope of applications that they are undertaking.

Animations for understanding concepts in electromagnetism; a WWW-based interactive geology tutor; hypermedia environments for foreign language learning; collaborative design in the studio of the future for architecture – the landscape of educational technology applications at MIT is rich with numerous initiatives that are varied in terms of their scope, specific technology employed, the nature of the application as well as the pedagogical approaches and techniques adopted. They all have the potential to transform the content, curricula, and even the clientele for an MIT education.

[See *http://web.mit.edu/acs/www/acaduses2.html* for some educational uses of IT at MIT.]

These projects hint at and highlight several positive transformations that can be enabled through IT use in education, including the following two broad attributes:

1. Proximity – between the learner and materials, learner and instructor, students and their peers, education and the workplace, novices and experts. Increased proximity is illustrated by access to discussion lists and databases formerly available only to professionals, simulations of reality that are as compelling as reality, "visiting" foreign countries as well as other opportunities created by the Web and video-conferencing.

2. Transparency – animations, modeling, and simulations enable a glass-box approach to understanding complex physical phenomena; the ability to play experimental games makes a rethinking of traditional methods of hypothesis testing possible; collaboration with peers, interactions with experts and the ability to access current (almost real-time) data and primary resource materials foreground the problem-solving process in research and industry.

Embedded in these value-adding opportunities are also several interesting, sometimes challenging and often value-laden issues encountered by faculty using technology to teach (as well as students using information technology for learning). These issues revolve around:

• bringing real-life experiences (problems and professional tools) into the instructional process;

• development of critical thinking skills, problem-solving in content areas and the fostering of interdisciplinary knowledge (i.e., going beyond pre-compiled software simulations and displaying second-hand compositions);

• assessment of the transformations enabled by technology;

• increased interaction/collaboration between students, as well as between students and faculty;

• new learning, new territories, i.e., unanticipated/unfamiliar realms and consequences; new logistics;

• representation, reinterpretation and (re)construction of knowledge; (discriminating representation from reality, understanding and resolving conflicting world views);

• ethical, legal, and social issues related to teaching and learning in the electronic realm; and

• issues of professional advancement and reward with electronic instruction.

In the four months or so that I have been at MIT, I have been familiarizing myself with the people and projects of academic computing in IS (Information Services) and the academic departments. Much of this was done as part of the annual visits with all department heads or their representatives to identify needs and concerns. Conversations with faculty in the course of these visits suggest that there is interest in opportunities to share information on the array of strategies, resources, and solutions being employed across departments, as well as on some of the challenges and issues associated with the use of information technology in the educational process at MIT. In short, there is an interest in developing a *community of practice* ["...a group of people who are informally bound to one another by exposure to a common class of problems...you can define them in terms of the learning that they do over time...it forms around a value adding something we're all doing..." **The Invisible Key to Success**, Thomas Stuart, *Fortune*, Aug. 5, 1995, pp. 173-175] around technology, teaching, and learning.

Crosstalk – A Forum for Technology, Teaching, and Learning
Kumar, from preceding page

What are we doing about IT?

Academic Computing, in collaboration with Undergraduate Education and Student Affairs, is in the initial stages of planning a forum on "Technology, Teaching, and Learning" that could serve an important role in the constructive furthering of the Institute's educational technology agenda. The forum, which would meet periodically, would provide opportunities for: (1) examining and articulating the role of information technology in teaching; (2) identifying aggregated technology needs and exploring the synergy of solutions. It would facilitate the growth of this community of practice.

Some questions that this proposed forum would help sharpen and address include:

• What is different in the approaches (technology and pedagogy) adopted in different courses? What is common?

• Are there ideas that have potential applicability elsewhere, other than the originally intended domain?

• Are there common problems and needs with implications for IS efforts and priorities?

• Are there opportunities for resource sharing and leveraging?

• How can technology-based instruction be improved and re-structured for improving student learning needs?

• How can technology be used to bring the excitement of research to the instructional environment?

• What are the infrastructure enablers for deriving more pedagogical gain from educational technology?

• How do you measure quality in light of the changes induced by technology in the educational process? (Elsewhere in this issue [Page 18] Prof. John Belcher from the Physics Department points to innovations in physics education to urge greater engagement in processes to assess and understand the educational potential of emerging technology.)

• What is the quality of cyberspace as a learning environment? (The message in the wry joke about the WWW which is making the rounds at MIT is significant: "The Web is a Write-Only medium...because there is no time to Read all the stuff on it.")

• How does technology influence the social relationships of teaching, learning, research?

The forum will complement efforts that are already underway (such as those of the Council on Educational Technology) to envision how we might construct new information environments that will include qualities to augment our instructional and scholarly practices.

The forum will feature a mix of strategies:

1. Case Presentations, which describe the details of the development and use of information technology components in courses, will help faculty share experiences and perspectives on the use of technology in the curriculum. Presentations will also emphasize the transformations in content, methods and culture of the classroom. They will address the impact on student learning. Presentations could include departmental as well as project site visits (field trips).

The cases will serve as an important resource for faculty in their efforts to integrate technology use in their courses. They will provide important inputs to IS (Academic Computing) on attributes we might wish to include in the ways we design and build information as well as for planning services and resources. (For example, it might be useful to compile directories of software along with their scope of application in various disciplines as well as listings and descriptions of the technologies being used.)

2. Presentations and discussions will be led by representatives from other institutions on topics and issues central to the use of technology for teaching and research, such as,

• Distributed Learning and Continuous Education;

• Assessment and Evaluation of technology's impact on instruction and learning.

Earlier this year, at the "Seminars on Academic Computing" in Snowmass, Colorado, Peter Lyman, librarian at UC Berkeley made the following observation in his keynote presentation [**The Unbecoming of Education As We Know It**]:

...in 20 years I have to say...academic computing has always been in crisis and that makes it interesting. It is essential that it remain in crisis because it is one of the places where we can see the evolution of higher education....

(See *http://www.orst.edu/groups/sac/index.html* for additional items of interest.)

Perhaps the forum on Technology, Teaching, and Learning could be one way to fuel this crisis.

We would like to hear about your interest in this activity as well as ideas that will help with its implementation. Please contact Naomi Schmidt, manager, Planning and Support in Academic Computing (*nschmidt@mit.edu*), Rosalind Williams, dean for Undergraduate Education (rhwill@mit.edu), or me *(vkumar@mit.edu)*.✤

Athena Training Opportunities
For Your Students

Jeanne A. Cavanaugh

The Athena Computing Environment has become an integral part of the MIT educational experience. As of Registration Day this year, over 80% of the freshman class and over 90% of the incoming graduate students had Athena accounts.

Electronic mail, the Zephyr interactive message system, NEOS (the Networked Educational Online System) for electronic submission, exchange, annotation, grading and return of assignments and course handouts, and OLTA (On-Line Teaching Assistant), are proven ways faculty members have successfully used Athena to work more closely with their students. Many classes also make use of MIT-developed or third-party educational software as part of their curriculum.

Five Electronic Classrooms, with Athena workstations at each desk and an instructor machine attached to a projection system, can be reserved for lectures and labs. (Six Institute classrooms are also equipped with an Athena workstation and projector; these rooms are reserved through the Registrar's office like any other classroom.) New software is added regularly to Athena software suites. If you wish to learn more about how Athena can be used in courses, please contact the Academic Computing Services Faculty Liaison Office, E40-357/359/360, x3-0115, <f_l@mit.edu>.

In order for MIT students to successfully use Athena, Information Systems offers a comprehensive series of short courses (called minicourses) on a variety of Athena-related topics. These courses are offered frequently throughout the academic year.

During R/O week, incoming freshmen, graduate, and transfer students had the opportunity to attend four basic courses: Intro to Athena, Working on Athena, Basic Word Processing and Electronic Mail, and Advanced Word Processing with EZ. These courses are offered before classes start, so new MIT students can become familiar with the system before they receive their first problem sets and paper assignments.

During the coming year, IS is offering new and revised 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. The courses are offered Monday through Thursday at noon, 7pm, and 8pm in Room 3-343. No registration is necessary, and they are free. There are two new courses this fall, one on FrameMaker and one on HTML.

We would like to 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 courses offered.

Introduction to Athena (Intro)
Pre-requisites: None
An introduction to Athena and Athena workstations. Topics include: what you can do on Athena, getting an account, logging in, windows, sending messages, finding help and documentation.

Basic Word Processing (Basic WP)
Pre-requisites: Intro
Elementary text editing with Emacs, sending and receiving electronic mail, and using the Athena printers.

Working on Athena (Working)
Pre-requisites: Intro, Basic WP
Just the basics: files, directories, job control, and more. What every new user should know about UNIX, Athena's operating system.

Advanced Word Processing: EZ (EZ)
Pre-requisites: Basic WP
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: LATEX (Latex)
Pre-requisites: Basic WP
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 the capability to typeset many foreign characters and very complex mathematical text.

Customization on Athena (Dotfiles)
Pre-requisites: Serious Emacs, some Athena experience
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 the user can make to those and other files to customize their working environment.

Introduction to FrameMaker (Frame)
Pre-requisites: Intro, Basic, WP, Working
FrameMaker is a powerful word-processing and document preparation package now available on Athena.

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

Athena Training Opportunities For Your Students

Cavanaugh, from preceding page

Information Resources on Athena (Info Res)
Pre-requisites: Basic WP
A survey of the communications, help, and other resources available on Athena.

HTML – Making a WWW Home Page (HTML)
Pre-requisite: Info Res
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.

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

Maple (Maple)
Pre-requisites: Basic WP
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.

Math Software Overview (MSO)
Pre-requisites: Basic WP
A survey of major mathematics and graphing packages available on Athena.

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

Serious Emacs (Ser. Emacs)
Pre-requisites: Basic WP, some Emacs experience
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.

Xess (Xess)
Pre-requisites: Basic WP
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.

Athena(R) is a registered trademark of the Massachusetts Institute of Technology.✤

Annals of Reengineering
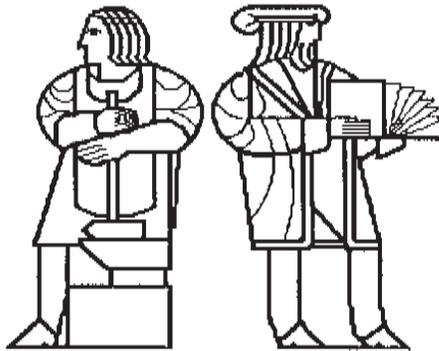
Training & Development Programs

MIT Personnel Office
Fall Semester 1996

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Where the Sun Shines, There Hack They

Samuel Jay Keyser

The title of Brian Leibowitz' historical compendium of MIT hacks, "The Journal of the Institute for Hacks, Tomfoolery and Pranks at MIT," (MIT Museum, 1991) is itself a hack. Embedded in it are the initials IHTFP, which, as everyone at MIT knows, stand for "I hate this fucking place." This is not the acronym's only "public" commemoration. The class of 1995 changed the date embossed on the dome image in the class ring from MCMXVI to IHTFP, something obvious only to a magnifying glass or a sharp eye. Earlier classes have done similar recodings of the MIT ring.

During my years as associate provost for Institute Life, many friends, colleagues, and associates approached me with this question: If students hate this place, then why don't they just plain leave it? It is a good question to which, I think, there is a good answer: they DON'T hate this place. But if they don't, the conversation continues, why say they do? An equally good question.

The answer lies, I believe, in unpacking the hacking. When we do, we find the practical joke cum parody lurking beneath. The practical joke is physical in character. One does not tell practical jokes. One plays them. Similarly, one does not tell hacks. They, too, are played. Here is how Arthur Koestler describes the practical joke in his Encyclopedia Britannica article:

The coarsest type of humour is the practical joke: pulling away the chair from under the dignitary's lowered bottom. The victim is perceived first as a person of consequence, then suddenly as an inert body subject to the laws of physics: authority is debunked by gravity, mind by matter; man is degraded to a mechanism.

The operative words here are "authority debunked." The hack is a physical joke designed to do just this. But it is not any physical joke. Hacks have a strong element of the parody in them. They are physical jokes which parody the honest work of an Institute grounded in science and engineering. That is why MIT hacks, unlike hacks at other institutions, almost always have

> Hacks have a strong element of the parody in them. They are physical jokes which parody the honest work of an Institute grounded in science and engineering. That is why MIT hacks, unlike hacks at other institutions, almost always have a strong engineering component. They make fun of engineering by impersonating it and then pulling the seat out from under.

a strong engineering component. They make fun of engineering by impersonating it and then pulling the seat out from under. MIT hackers typically don't throw pies or wrap underwear around statues of founding fathers. Rather, they make large objects appear in inaccessible places, rewire lecture hall blackboards to go haywire when the instructor tries to use them, replace chiseled wisdom on friezes with silly sayings in what appears to be identical script and then do so so cleverly that it takes a few days for the community to realize it's been hacked and then requires a swat team of trained rappellers to dismantle it.

Why does MIT hacking have such a long half-life? The answer lies in something called "disobedient dependency." In order to stay in a dependent relationship that is both desirable and yet threatening, one

coping mechanism is disobedience. It distances the dependency, makes it bearable. Let me give a not-all-that-extreme example drawn from my experience as a housemaster at Senior House to make the point.

During the 80s President Gray and his wife gave garden parties for the parents of incoming freshmen. The President's garden was filled with incoming sons and daughters and their parents. Several Senior House students took this as an opportunity to be ostentatiously disobedient. They would dress as grundgily as possible. Then they would scale the wall separating the Senior House courtyard from the President's House garden and mingle with the well-dressed, well-scrubbed guests, scarfing crabmeat sandwiches as if they were auditioning for the part of John Belushi in a remake of A*nimal House*. The more outrageous the behavior, the better. Some of the more inventive students would dress up as characters from *The Rocky Horror Picture Show*. Most, however, did not, attempting to *epater le bourgeois*, as it were, without props. More often than not, someone would dump a bottle of detergent in the garden fountain to intensify the nuisance value of their presence.

Where the Sun Shines, There Hack They
Keyser, from preceding page

The superficial motive behind such "disobedience" was to embarrass those in authority, the President, his spouse, the various deans and housemasters who showed up for the occasion. The crashers were declaring their independence from the Institute and all its folderol. The deeper motive was to provide distance between themselves and the Institute so that its judgments of them, upon which they deeply depended, would be, when they were made, less painful.

Why do I say that students deeply depend on the Institute's judgments of them? The reason is that the values of the students and of the faculty are virtually the same. For the most part the faculty are the best at what they do. The students come here to be like them. When the faculty grade them, those judgments can be painful because the students believe they are true. At some level our students know that while they are all in the top 5 percent of their high school classes, they will soon be recalibrated downward. I say "at some level" because a poll taken not too long ago asked the incoming class how many of them thought they would end up in the top quarter. Something like 75 percent said they would! At least half of those responding were about to discover they were not as good as they thought, not an easy pill to swallow at any stage of one's life.

Unlike the extreme kinds of disobedience that one often finds in living groups, the hack is a socially acceptable form of disobedience. It is easily distinguished from its more extreme counterparts by three properties. Hacks are: (1) technologically sophisticated, (2) anonymous, (3) benign. They are technologically sophisticated because they need to parody an MIT education. They are anonymous because were they otherwise, the Institute might be forced, if only for safety reasons, to do something about them. They are benign because their goal is not to inflict pain, but to cope with pain inflicted. They do this by making fun of the Institute, diminishing it, bringing it down to size

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so that its judgments are brought down to size as well.

The hack is a pact that the Institute and its students enter into. Keep it anonymous, harmless, and fun and MIT will look the other way. It will even be mildly encouraging because it recognizes, as do the students, that students need to turn the Institute into an adversary. This, by the way, is why the adversarial undercurrent between students and the Institute won't go away, no matter how supportive student services are or how solicitious our staff might be or how accessible the faculty makes itself.

The hack isn't the only buffering mechanism. Another is the special relationship that students have to their living groups. Why does where a student lives take on such monumental proportions at MIT? Part of the answer

is that living groups function much like disobedience; namely, as a kind of protection against the slings and arrows of institutional judgment. Living groups are safe houses, ports in a storm, raingear to keep them dry once the firehose is turned on. This them/us division is so profound, in fact, that long after they have graduated, students talk in terms not of having been at MIT, but rather of having been at Senior House, or Sigma Chi, or MacGregor. MIT tacitly acknowledges this as well, which is why the very peculiar system of residence selection during R/O is virtually impervious to change. No one really wants to do anything about it, or can, for that matter. Its buffering function is as much a part of an MIT education as are the general Institute requirements. The same is true of hacks.

Hacks and living groups, then, are to the Institute what sunglasses are to the sun: a form of protection that makes it possible to live with the light. Not every student hacks. Not every student feels the same degree of disobedient dependency. But every time hackers help to place a police car on the dome, they are providing shade in a very sunny clime.✤

Teach Talk

Trends in Science Education

John Belcher

I lectured 8.02, Physics II, Electromagnetism (the 750 student, on-term version) a few years back. As a result, I have become interested in the conceptual difficulties that freshmen have when they encounter MIT's core science subjects. So, after 25 years of being on the faculty here, I have for the first time in my professional career attended two conferences focused exclusively on education.

At the beginning of August, I attended the International Conference on Undergraduate Physics Education (ICUPE), July 31-August 3, 1996, and later the American Association of Physics Teachers (AAPT), August 5-10, 1996, both held at the University of Maryland at College Park.

Although much of what I learned at these conferences is old hat to many people at the Institute, much of it is new to me. The context is physics education, but much of it applies to science education in any of the core disciplines. These are a common set of issues that we all deal with. I think it is worthwhile to give a brief summary of what I found to be of interest at these meetings. A lot of this material is on-line. To reach the on-line resources, take a look at this article at *http://web.mit.edu/jbelcher/www/trends.html*.

Given the extensive history of educational reform in this country, both here and elsewhere, my preconception before I went to these meetings was that what *can* be done, probably *has* been done in physics education. But I was wrong. This is a lively field, with a theoretical underpinning based on general research in education, with new modes of teaching, many based on

advanced technology, and with a variety of assessment tools used to evaluate the effectiveness of teaching methods. Both meetings I attended had a number of workshops illustrating various teaching innovations, some of which I will mention below. The area I found most interesting is research into methods used in the general science education of engineers and scientists (i.e., what we do in our freshman core science subjects), and that is what I will focus on here.

What does research in education have to say about teaching methodology in the freshman year? Over the last decade, a number of studies seem to show that the lecture/recitation format in its traditional form is not very effective in getting conceptual material across. Although the format has some success in teaching problem solving, it leaves glaring holes in conceptual understanding. There is quantitative weight to this statement. There are a number of physics education research groups, both in the U.S. and abroad (many with Home Pages) which study these issues, in part by using assessment tests given both before and after courses (in mechanics, for example). One such test is the Force Concept Inventory (FCI) (*The Physics Teacher* **40**, 141-153, 1992). Such tests have been used in conjunction with a number of physics courses across the country, including courses at Harvard.

A problem typical of these assessment tests is the following. A ball is thrown straight upward. *Disregarding any effects of the air*, the force(s) acting on the ball from the moment it leaves until it returns to the ground is (are): (a) its weight vertically downward along with a steadily decreasing upward force; (b) a steadily

decreasing upward force until it reaches its highest point, after which there is a steadily increasing downward force of gravity; (c) a constant downward force of gravity along with an upward force that steadily decreases until the ball reaches its highest point, after which there is only the constant downward force of gravity; (d) a constant downward force of gravity only.

The answer to this question is (d); many students give (c) as the correct answer (why do you think this is so?). The interesting result is *not* that a fair number of students answer this question incorrectly *before* they take a course like 8.01, but that a substantial number *still* get it wrong *after* taking a course like 8.01. That is, the standard course in the standard format *does not change the student's basic conceptual framework about mechanics very much*. This is not because the students are dumb. It is because the standard course we teach is not effective at changing preconceptions or misconceptions that the students bring with them.

Why is this so? An answer to that question is contained in the article *The Implications of Cognitive Studies for Teaching Physics* by Edward Redish (*The American Journal of Physics* **62**, 796-803, 1994). [This article can be found on-line; see the URL given above.] Cognitive studies are about how people understand and learn. Constructivism in cognitive studies postulates that: (1) people tend to organize their experiences and observations into patterns or mental models – the student does not come to us as a blank slate; (2) it is reasonably easy for the student to learn something that

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matches or extends an existing mental model; (3) it is very difficult to change an established mental model substantially; (4) different people have different styles of learning.

There is a wealth of detail in the article by Redish that expands on these points, and cites the relevant literature, and I strongly recommend it. In particular, with regards to different learning styles, there is a passage from Redish that I quote below. We should all keep the

own classes. This training stretches us even further from the style of approach of the "typical" student. Is it any wonder why we don't understand most of our beginning students and they don't understand us?

If we accept the fact that our introductory courses do not get basic conceptual ideas across to many of our students, what do we do about it? The pervasive answer in the community at these two meetings is the abandonment

> **What does research in education have to say about teaching methodology in the freshman year? Over the last decade, a number of studies seem to show that the lecture/recitation format in its traditional form is not very effective in getting conceptual material across. Although the format has some success in teaching problem solving, it leaves glaring holes in conceptual understanding.**

following in mind. It is appropriate for any faculty teaching introductory courses in the sciences (not only physics), especially at a place like MIT, where the faculty have been outstandingly successful in their own disciplines from an early age.

Our own personal experiences may be a very poor guide for telling us what to do for our students. Physics teachers are an atypical group. We selected ourselves at an early stage in our careers because we liked physics for one reason or another. This already selects a fairly small subclass of learning styles from the overall panoply of possibilities. We are then trained for approximately a dozen years before we start teaching our

of an exclusive emphasis on problem solving, and a modification of the traditional lecture format to permit teaching of underlying concepts. "Teaching of underlying concepts" usually means some sort of active interaction between student and teacher, or student and student, frequently mediated by technology, as opposed to the passive "telling" mode of traditional lectures. There are well-documented examples of approaches along these lines which are much more successful in getting across basic conceptual material than the standard lecture format. "Successful" is again defined quantitatively in terms of the results of standardized assessment tools, such as the FCI mentioned above.

For example, there is the *Peer Instruction* approach of Eric Mazur at Harvard University. In this approach, used in a one-year calculus-based introductory physics course for science concentrators, "...the lectures are broken in 12-minute long sections. Each section starts with about 7 minutes of lecturing on one of the fundamental concepts to be covered. This mini-lecture is then followed by a short multiple-choice question that tests the students' understanding. After one minute the students record an answer and are then asked to turn to their neighbors to try and convince them of their answers. After another minute or so, the students are asked to reconsider their answer and record it again. A poll is taken so the instructor can decide whether to move on to the next concept, or to continue on the same. This process repeats until the end of the class...". The polls are taken electronically, with the results instantaneously posted in histogram form visible to the entire class. Assessment data show a dramatic gain in student performance compared to that in the same course taught in the traditional lecture format.

There are other such efforts involving innovative teaching methods, which I will reference here but not detail: the *CUPLE* (Comprehensive Unified Physics Learning Environment) approach of Jack Wilson of Rensselaer Polytechnic Institute; the *Microcomputer-Based Laboratory* (MBL) approach of Ron Thorton of Tufts University; the *Physics by Inquiry* approach of Lillian McDermott of the University of Washington; the *Workshop Physics* approach of Priscilla Laws of Dickinson College; a workbook approach to teaching *Electric and Magnetic Interactions* using integrated

Trends in Science Education
Belcher, from preceding page

desktop experiments, from Ruth Chabay and Bruce Sherwood of Carnegie Mellon University; the *RealTime Physics* laboratory approach, featuring the comprehensive use of microcomputers for data collection and analysis, by Sokoloff, Laws, and Thorton, among others.

Most of these approaches use assessment tools to measure in some quantitative fashion the effectiveness of

and acceleration, and so on, all in an interactive laboratory environment.

The use of these approaches has been successful in a variety of venues. Rutgers University has a class, Extended Analytic Physics, which is a first-year calculus-based physics course for students who plan to become engineers, but who enter with poor preparation in physics and mathematics. The lectures in this course use an anonymous student response

students in Extended Analytic Physics (about 120 students) take the same final as the parallel Analytic Physics (about 450 students), and on average *do better on that final than the mainline students.* These are remarkable results; someone at Rutgers is doing something right. In student interviews, all of the Extended Analytic Physics students felt that the hands-on, cooperative nature of the weekly workshop was important to their success, as was the anonymous student response system used in lecture, a technology-facilitated innovation. However, the students in Extended Analytic Physics were also uniform in saying that it was very important to them that the lecturer knew their names. We live in an age of transforming technological advances. Some things do not change, though.

> **What are the take-home messages of all this? First, there is a lot of research and innovation in core science education going on....Second, there is a focus on the use of quantitative assessment tools to see if what we intend to teach students is what they learn. Such tools have been used in the last decade to examine the results of both our traditional approaches and results of innovative approaches.**

the pedagogy. Many of them involve the use of technology, but it is important to note that this use is frequently to *facilitate* faculty-student or student-student interaction, *not do away with it*. For example, the *Peer Instruction* approach uses interconnected small computers which provide immediate feedback to the students and to the instructor about the range of answers, which is then the focus of small group discussions. Other approaches mentioned above also make use of computers, e.g., digital video processing as a means of studying realistic examples of Newtonian mechanics, motion sensors in conjunction with computers to simultaneously measure and graph such physical quantities as position, velocity,

system similar to the Harvard *Peer Instruction* system. The class also has a weekly workshop that is a hands-on group activity, partially using the *RealTime Physics* MBL-based laboratory mentioned above. The Extended Analytic Physics students have about twice the contact hours as compared to the mainline Analytic Physics students, with smaller classes, and more diverse teaching methods.

This course and courses like it at Rutgers have been outstandingly successful. For example, the retention rate of minorities in engineering, who are one component of such courses, has gone from 9 percent in 1985, before such courses were introduced, to 50 percent in 1995. At the end of their first year, the

What are the take-home messages of all this? First, there is a lot of research and innovation in core science education going on. A lot of this innovation uses advanced technology to good effect. Second, there is a focus on the use of quantitative assessment tools to see if what we intend to teach students is what they learn. Such tools have been used in the last decade to examine the results of both our traditional approaches and results of innovative approaches.

There are innovative approaches out there which do much better than our traditional approaches, by this standard. Whether or not we agree with these innovative approaches, or the assessment tools by which they are judged, we should be aware of them. It is also clear that there is enormous educational potential in emerging technology. We at MIT, of all places, should be involved and knowledgeable about innovations in science education which make effective use of advanced technology.❖

Opportunities for Faculty–Alumni/ae Interaction

William J. Hecht

Did you know the Association of Alumni and Alumnae last year involved over 50 MIT faculty in appearances for a variety of Alumni-related programs? Most of these were with MIT Alumni/ae Clubs worldwide; others lectured on Travel Program trips, spoke to alumni audiences at Professional Society gatherings, met with Reunion Classes, and spoke at Technology Day.

Some of you have been a part of these programs; others might like to be. In response to specific requests from MIT Clubs and other programs, we typically have asked MIT faculty on an individual basis to participate, and we will continue to do so. At the same time, we have just reorganized and centralized some of our outreach programs and now wish to highlight the newly established Speakers' Bureau and the Alumni/ae Travel Program and how you, as faculty members, might interact with them. We welcome your participation, and hope you will be interested in joining us.

Alumni Association Speakers' Bureau To Coordinate Faculty Travel

The Speakers' Bureau will work closely with departments and other contacts to identify potential speakers, learn of conferences/seminars they attend, track speakers to MIT Clubs and other Association programs, and centralize our faculty travel process. We will survey faculty periodically to promote and generate interest in our programs, and to recruit for opportunities of interest.

Clubs are being asked to request speakers directly from the Speakers' Bureau, and to provide lead time (3-4 months if possible) and flexibility for arrangements. Clubs typically invite faculty to talk about their courses, their research, new initiatives at the Institute – in short, the things that make MIT a special place.

While Clubs are a main focus, the Bureau also will advise and support other Association activities such as the Alumni/ae Travel Program, Department and Reunion events, and Alumni Continuing Education. We will share information with other MIT staff and departments for possible joint programs.

Why Should I Do This? What Are The Benefits?

While the Bureau's main purpose is to bring faculty to alumni/ae, we also want to educate faculty and staff about the Alumni/ae Association and its programs. Faculty speakers volunteer their time to travel and speak to alumni/ae, and we want them to enjoy this interaction so they will want to do such events again in the future. Benefits to you and your departments include:

• travel to cities to which you might not otherwise go

• travel expenses paid by the Alumni Association, or coverage for an extra stay if already on Institute or other travel (MIT guidelines apply)

• promote your department and its/ your work

• meet with prior students/advisees

• establish a network of alumni/ae contacts

• experience the interesting challenge of adult learners – different from students

• allow a change of pace during a business trip

• receive satisfaction from providing an important service for alumni/ae and for MIT.

Contact us for more information: Bob Blake HM: MIT Room 10-116M, Ph: 3-8243; Fax: 8-6211; e-mail <rblake@mit.edu> or Catherine Brentani: Ph: 3-8248; Fax: 8-6211; email <brentani@mit.edu>.

Alumni/ae Travel Program Offers World Wide Lecture Opportunities

The MIT Alumni/ae Travel Program offers exciting, educational trips to alumni and other members of the MIT Community. To enrich the travelers' experience, the Travel Program has hosted meetings with domestic and international MIT Club members, and has invited MIT faculty to lecture during the programs.

Melissa Chapman, manager of the MIT Alumni/ae Travel Program, is looking to invite faculty members to lecture to alumni/ae on upcoming tours. Specifically, Melissa would like to talk to faculty members who would be interested in lecturing on a program to St. Petersburg, which will take place from March 1-8, 1997. Some of the program's site visits include the Winter Palace, the Yusupov Palace, the Hermitage, and the U.S. Consulate.

Coming up this September, Ford Professor Emeritus Lucian Pye will provide a lecture series to alumni traveling to China. Professor Pye lectured for the MIT Alumni/ae Travel Program for the first time three years ago.

One of the first trips of 1997 will be hosted by Ford Professor Emeritus Dr. Donald R. F. Harleman CE '50. For the second time, he will be lecturing to a group of alumni who will be making the passage through the Panama Canal.

Over the past year, MIT travelers have enjoyed lectures by Dr. James G. Bellingham '84, Principal Research Engineer of MIT's Sea Grant Program, during a cruise of the Virgin Islands; Professor Emeritus Ernst G. Frankel OE '60, of the Ocean Engineering Department, during a tour in China; and Professor Emeritus Robert V. Whitman CE '49, of MIT's Civil and Environmental Engineering Department, during a transcontinental train trip from Washington, D.C. to Los Angeles.

Please contact Melissa Chapman for further information. She can be reached at 3-8265, Fax: 8-6211, or e-mail <mchapman@mit.edu>.❖

New Department Helps Faculty Comply With Copyright Laws

Donna Mulholland

The MIT campus Copy Centers have a new name and a new department to help faculty comply with copyright laws. Since the reengineering of Graphic Arts, the Copy Centers are now called the Copy Technology Centers or Copy Tech. They will continue to produce Course Readers for faculty, with the added service of obtaining copyright permissions. The new service is called the Copyright Service and is meant to help faculty comply with existing copyright laws.

What are Course Readers and what is all this talk about copyright?

Faculty in most major universities use custom Course Readers (a collection of xeroxed articles or other material) to supplement text books. The Reader allows faculty members to teach with current material in a fashion that allows combining several sources into one volume, eliminating items from standard texts not required for a particular course.

The issues of copyright in general and that of course packets in particular is not a topic which faculty can ignore. A federal court in New York ruled in favor of Basic Books in a lawsuit against Kinko's Graphics Corporation and since then, creation of course packets for university use has been a very controversial issue. It is important for faculty to understand the legal implications of copyright law and how to protect themselves and the Institute from liability.

The law holds the Institute, the professor, and the Copy Centers equally responsible for infringement of copyright laws. The Institute has established a policy that addresses the issue and the Copy Centers have established this new service to help educate the community and process requests. MIT has a clearly stated policy that individual faculty have the responsibility to get the required copyright permissions for material contained in Course Readers. The Copy Tech Centers have established this new department to help facilitate this process. It is hoped that in order to avoid liability, faculty will access this new service. *Using the office copy machine to avoid proper permission procedures is not only more costly per copy, but does not in any way relieve the faculty or the Institute of liability.*

A pilot program was established by the Copy Centers during the last two semesters to help everyone become familiar with copyright procedures. A copyright administrator was hired to coordinate and process all requests for permission from publishers. She is available to assist faculty in understanding the laws and requirements and to answer any questions about this process. The Copy Centers also paid all royalty fees for the first two semesters to show good faith and to encourage participation. As of fall '96, any royalty charges will be added to the cost of the Reader. This new service helps to eliminate the time consuming tasks associated with requesting, tracking, and pricing copyrighted Course Readers. It can take from six to eight weeks for publishers to respond to copyright requests. So far, the most difficult thing for faculty has been this need for adequate lead time.

All Readers that are produced at the Copy Centers should be copyright cleared. This is done by filling out a simple copyright request form. The information needed is what you would find on a good bibliography: Title, Author, Publisher, Publication Date, Title and Volume of Journals, and Page Numbers. The information is then put into a computer database. A request is produced and faxed to the publisher or a copyright clearing house, such as the Copyright Clearance Center. The royalty charges, if any, are tracked, paid, and rolled into the cost of the Reader that the students then purchase.

Using statistics gathered during the pilot program, it has been determined that the average royalty cost of an article is $1.47 and that the price of Course Readers will increase due to these costs. The average price of a custom Course Reader is about the same as conventional textbook purchases, but given that the professor is the one putting the Reader together, the usage of the material is higher and therefore a better buy for the money.

The Copy Tech Center uses state-of-the-art high-speed copiers to reproduce these Course Readers. Readers are scanned and stored electronically, enabling faculty to have additional copies run on demand, usually by the next day. These new copiers can also straighten and clean up the pages of copy that is supplied. The pilot program also introduced a new look to Course Readers. Standardized covers are used and the copy can be bound in book form, providing a more professional look to these custom Course Readers.

The Copy Tech Centers encourage faculty to use this copyright service to help them get the required permissions for Course Readers. Any Reader reproduced in the Copy Tech Center must be copyright cleared before they can be sold to the students. Any questions regarding this procedure should be addressed to the Copyright Administrator of the new Copyright Service at 253-4765, or e-mail donnamul@mit.edu. Additional information can be accessed via our web page at *http://web.mit.edu/graphic-arts/www/.* ✣

Letters

To The Faculty Newsletter:

You requested comments, suggestions, or ideas relating to the *Faculty Newsletter* Home Page and the Faculty Bulletin Board.

My primary concerns are the potential disadvantages to making any Web site accessible from outside MIT. The principal purpose of the *Newsletter* is to improve MIT and its environment, not to provide a platform for external distribution of private views. Therefore, I see no apparent incentive for providing external accessibility. On the other hand, such a policy could diminish the unique and valuable service the *Newsletter* continues to perform.

First, it is clear that if the *Newsletter* is externally visible, contributors should appreciate that fact when they make their submittals. My concern is that certain submittals addressing delicate issues are then more likely to be inhibited, yet it is precisely such issues that the *Newsletter* can most uniquely surface. A second and related disadvantage is that not everyone external to MIT would understand the context of the discussion and could easily misinterpret or misrepresent (even deliberately) *Newsletter* discussions (e.g., "MIT faculty say..."). Finally, if the *Newsletter* becomes a widely accessed external document, it increases the temptation to politicize internal Institute discussions. My observation is that politicized dialogues are less productive.

In summary, to place the *Faculty Newsletter* in an externally visible Web site confuses its mission and inevitably detracts from it. Creation of a separate externally visible vehicle could be another matter, provided it did not get confused with the *Newsletter* or otherwise detract from the Institute. I hope these thoughts are helpful.

David H. Staelin, Professor
Electrical Engineering
& Computer Science

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Medical Department Offers Infertility Support Group

Rochelle Friedman

The MIT Medical Department is making available an infertility support group to all interested members of the MIT community.

Infertility often has a devastating psychological impact. It is common to feel intense emotional pain, to feel powerless and out of control of your life, as well as a sense of being damaged. Feelings of rage, guilt, envy, depression, anxiety, and stress are also common.

Many people find that infertility is an isolating experience which dominates months or even years of their lives. Friends and family members may not understand why it is difficult for you when others become pregnant, why you won't attend baby showers or christenings, or why Christmas is a sad rather than a happy time of year for you.

The MIT Infertility Support Group is a place where you can talk about your feelings and people will understand what you are going through; where you can share information; where you can trade experiences. The group meets every Friday from 12 to 1 pm in the third floor group room in the Medical Department.

If you would like more information or if you would like to join, please call Dr. Rochelle Friedman, 253-2916.✤

M.I.T. Numbers

Freshman Enrollment
1995 & 1996

	1995	1996	Change	% Change
Freshman Applications	7958	8022	64	1%
Freshman Accepted	2113	1947	-166	-8%
Freshman Enrolled	1117	1071	-46	-4%
Percentage Enrolled	53%	55%		2%
Male	647	623	-24	-4%
Female	470	448	-22	-5%
Percentage of Women in Class	42%	42%		0%
International	81	87	6	7%
Afro American	66	74	8	12%
Mexican American	58	67	9	16%
Native American	5	15	10	200%
Puerto Rican	27	32	5	19%
Total of Four Groups Above	156	188	32	21%
Percentage of Four Groups in Class	14%	18%		4%
Asian American	316	293	-23	-7%
Percentage of Those Ranked Who Were Valedictorians	35%	37%		2%
Percentage of Those Ranked Who Were in Top 5%	87%	84%		-3%
SAT-I Verbal Mean	636	700	64	10%
SAT-II Math Mean	744	748	4	1%
Percentage Indicating an Intention of				
Concentrating in EECS	22%	22%		0%
Concentrating in Biology	14%	13%		1%

Source: Office of Admissions