

The MIT Faculty Newsletter

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Research at MIT

School of Humanities, Arts, and Social Sciences

Some Comments on the Organization and Direction of Research

Philip S. Khoury

Introduction

Research in the School of Humanities, Arts, and Social Sciences (SHASS) is wide ranging. It stretches from behavioral economics and political economy to international relations and comparative history, from the history and anthropology of science and technology to the cultural analysis of new media, and from comparative literary criticism and musicology to the philosophy of mind and the deep structures of language. Artistic expression – creative writing, musical composition, and theater – is also very much part of the SHASS mix.

The culture of the single-investigator prevails in SHASS disciplines and fields. Research assistants may contribute to individual faculty research, but doctoral students are encouraged to develop independent dissertation topics apart from their supervisor's research. Nonetheless, in Economics, Linguistics, and Political Science collaborative research is increasingly important. Although laboratories are few, there are highly innovative labs in Comparative Media Studies, Foreign Languages and Literatures, and Linguistics.

The boundaries of SHASS academic units are increasingly porous. Anthropology, History, and the Program in Science, Technology, and Society straddle the humanities and social sciences. Our novelists, short story writers, and poets are as

(Continued on Page 4)

Editorial

We Need Your Help

In January of 1997, after many discussions and negotiations, President Vest signed an agreement to fund the *Faculty Newsletter* and to provide administrative support for another five years. The continued editorial autonomy of the *Newsletter* was confirmed, and a review by a committee appointed by the President would take place in 2002. Last January that review committee (headed by Chair of the Faculty Steve Graves) began meeting.

The Committee sought out and interviewed faculty from across the Institute, including all the current members of the Editorial Board of the *Faculty Newsletter*. They released their report late last summer. The purpose of this editorial is to provide you with some highlights of that report, and to seek your assistance in complying with the Committee's major recommendations.

The Report notes that virtually all faculty value the *Newsletter* and wish it to continue. Suggestions were made about types and length of articles, topics to be addressed, and other ways to improve the publication. But the strongest recommendation concerned the need to continually renew faculty participation.

We need you to help us with this. It is **your** *Newsletter*, and your articles and e-mail comments and suggestions will make this a better, more representative voice of the faculty. But the most important need is for you to join the *Newsletter* Editorial Board. It's really not much work – the Board meets a couple of times a year in a cordial setting (usually someone's department conference room) and we even serve refreshments. Board members are asked to serve on an Editorial Committee for an upcoming issue, which involves one or two brief

(Continued on Page 3)

This issue of the *Faculty Newsletter* continues the theme of research at MIT with the above overview of his school by Dean Khoury, Professor Sheila Widnall's testimony to Congress (Page 6), and an overview of the OCR Knowledgebase (Page 14). We hope to publish an overview from Dean Mitchell of the School of Architecture and Planning in the future.

From The Faculty Chair — Page 3
Teach Talk — Page 10
Humanists and the Cambridge-MIT Institute — Page 13
Letters — Page 15
Contents — Page 2

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MIT Faculty Newsletter

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Contents

School of Humanities, Arts, and Social Science

Some Comments on the Organization and
Direction of Research 1

Editorial

We Need Your Help 1

From The Faculty Chair

Our Good Fortune 3

Testimony Before the House Committee on Science 6

Teach Talk

Enhanced Conceptual Understanding 10

Language, Film, and Technology Workshop
Aligns Humanists with Cambridge-MIT Institute 13

Research Database Provides Entire Institute
Information on Faculty Research Projects 14

Letters

Theory of Relative Thoughts 15

M.I.T. Numbers 16

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From The Faculty Chair

Our Good Fortune

Stephen C. Graves

In the last issue of the *Faculty Newsletter*, I wrote about faculty workload and what might be done to improve the quality of life for faculty. I seemed to have touched a nerve as I have gotten a number of responses, expressing an interest in discussing and exploring how to make things better. I am quite encouraged by this and am hopeful that we can and will initiate a process to take a serious look at how best to address quality of life issues. This is an ongoing topic of discussion with the administration, the Faculty Policy Committee, and the Council on Family and Work. There will be more to come.

Having said that, I want now to turn the tables, and remind us about what is so special about being a faculty member at MIT. Indeed, for me, it is a privilege beyond my wildest dreams. This is not to say that things could not be better. But all in all, I view myself as being incredibly fortunate, each and every day I come to school. I suspect this is true for many of us.

Much of what is good about MIT is obvious and maybe goes without saying. But I think it's important to highlight and remind ourselves, as the longer we are here, the more we take for granted. When I think of what I do in comparison to my non-MIT friends and neighbors, I'd cite five elements, in no particular order. Your list might be quite different and I am sure there are other considerations that I have overlooked. But these are the features that I think make our job so special.

As should be the case, *MIT students* come first. They are bright, fresh, and engaging. They continually challenge us and are the stimulus for much innovation and discovery. They work incredibly hard in a cooperative and collegial way; and then they go off and accomplish things that make us proud. Many become our life-long friends and some end up as our colleagues.

As faculty, we have tremendous *freedom* to choose what we want to do and how we want to do it. I don't recall anyone ever telling me what to do – at least not at MIT. Of course, we assume teaching assignments, but beyond that we can pretty much set our own schedule and agenda. This freedom sometimes makes it hard to explain to the kids what we do each day. But it is an essential condition for the innovation and creativity that we see day in and day out at MIT.

I take great *pride* in being part of MIT. It is not just that MIT is a great institution with outstanding faculty and students, doing great things. But rather, MIT is a great institution that does the right thing and does things in the right way. We have repeatedly demonstrated a willingness to take a stand on the tough issues of the day, to stick by our principles and values, and to pursue the noble goals of service to our nation and to humanity. The administration and the faculty practice strong and principled leadership on a variety of fronts, and as such, make for an organization of which one is honored to be a member.

In spite of reports to the contrary, I find a vibrant and diverse *community* at MIT. MIT attracts good people to the faculty and staff, generally treats them well, and rewards them based on merit and accomplishment. We have a healthy, positive work environment, with minimal hierarchy and politics. People get along, with mutual respect and support, and seem to work well together. And our faculty and staff care about what they are doing and about each other, leading to a fairly strong sense of community.

Finally, I'd mention the *security* we get from tenure. We have a job for life. These days there is virtually no other job category that provides such a guarantee. Knowing that you will never be "between jobs" or trying to make ends meet as an independent consultant, is an incredible luxury, providing invaluable peace of mind for a worrier like myself. I appreciate that a junior faculty member might not have quite the same perspective at this time; but for those of us with tenure, it is a remarkable privilege that truly distinguishes the nature of our employment.

So, I find myself quite thankful for my good fortune. Certainly at times there is too much work to do – the hours are quite long and the rewards seem dubious. And we can most surely make improvements in how we do our work, and how we balance work, family, and other aspects of our lives. But at the same time, we shouldn't lose sight of what's so good and special about our positions as MIT faculty. ♣

[Stephen C. Graves can be reached sgraves@mit.edu]



We Need Your Help

from Page 1

meetings and subsequent e-mail communications to solicit articles from faculty members we think would have something interesting to say on the topic we have chosen. And that's about it.

We wish to thank President Vest and the Graves Committee for providing valuable

input and constructive suggestions for the improvement of the *Newsletter*. But it's really you, the MIT faculty we want to thank for your past help, and we'd like to be able to thank many more of you for future help making *The MIT Faculty Newsletter* continue its unique role as a

voice for the faculty. Please contact us by e-mail (fnl@mit.edu), snail mail (Bldg. N52-419a); telephone (x37303), or by contacting any of the Editorial Board members listed on Page 2. Please – we can't do this without more help from you. ♣

Editorial Committee

Some Comments on the Organization and Direction of Research

Khoury, from Page 1

much a part of the humanities as they are part of the arts. Linguistics and Philosophy are closely engaged with Brain and Cognitive Sciences and Computer Science. Economics at MIT has long employed mathematical tools, and some areas of Political Science increasingly do. Music and Theater Arts includes historians, composers, conductors, performers, playwrights, and directors. Interdisciplinary research is a hallmark of SHASS.

Funding

The main sources of research funding are the major private foundations – Mellon, Ford, Carnegie, and Sloan in particular – and the NSF. Yet because private foundations do not pay full indirect costs, there are barriers to privately sponsored research. SHASS's largest and most important research arm in the social sciences, the 50-year-old Center for International Studies (CIS), is particularly vulnerable to this disincentive. The School is striving to ensure that under-recovery does not become a serious constraint to research initiatives. Artists and humanists at MIT, and across the United States, have been hampered in their creative activities and scholarship by deep budgetary cuts in the 1990s at two vital government agencies, the National Endowment for the Arts and the National Endowment for the Humanities. Fortunately, the Kenan Sahin Fund, established in 2001, and the SHASS Research Fund are helping faculty in the arts and humanities to pursue their creative and scholarly agendas in the absence of sustained external funding.

Examples of Ongoing Research and Artistic Expression

Linguistics

MIT Linguistics has defined the field for over 40 years. MIT faculty revolutionized the study of language by relocating the object of study from “external” language use of texts and tongues to the bases of language in the mind and brain. This emphasis provided a scientific basis for the study of language and replaced the earlier descriptive foundations of the discipline. In recent years, the meaning of words and sentences has been more directly integrated into the general theory of grammar, with semantics taking its place beside phonetics as crucial fields in the comprehensive science of linguistics.

During the last few years, MIT has again taken the lead by merging linguistic theory and brain science. MIT's new MEG (magnetoencephalography) Laboratory exploits the latest brain imaging technology to reveal how the brain computes language. Findings from the Lab on morphological processing are beginning to reshape linguistic theory. MEG research is now investigating reading and dyslexia. Language processing in the visual modality illuminates problems of structural decomposition at the word and sentence level, and the disruption of reading in developmental dyslexia serves as a microscope for understanding unimpaired language processing.

Literature

The MIT Literature Faculty has had a major impact on scholarship in several key fields, including Shakespeare and

the Renaissance, and in new areas of research on the literature of travel and cultural exchange, media studies, and gender studies.

Faculty in Literature and in Foreign Languages and Literatures are at the forefront of research in the application of new technologies to humanities research and education. One of the most innovative projects is the MIT Shakespeare Electronic Archive, which links all relevant materials across all media (early texts, art and illustration, film and filmed performances) to the lines of text to which they refer. The Archive is now available at MIT and collaborating institutions, including the Folger Library, the University of Pennsylvania, and the Shakespeare Institute in Stratford-upon-Avon. The Archive group is involved in a joint project with Microsoft to extend this media-rich approach to remote collaborations and discussions, linking DVD and streaming video versions of Shakespeare films and plays to the other materials of the archive in a comprehensive and flexible annotation system. Early versions of the Shakespeare Annotation System have been used in MIT classes and have formed the basis for the first “video enhanced” scholarly distance seminars for the Shakespeare Association of America.

Music and Theater Arts

The Music and Theater Arts Section has grown around a core of creation and performance that is part of the hands-on research culture at MIT. In Music, senior composers have achieved international recognition. While maintaining strong leadership in the study, performance,

(Continued on next page)

Some Comments on the Organization and Direction of Research

Khoury, from preceding page

and composition of Western classical music, the Music section also leads the cross-cultural movement in popular and classical music composition and performance.

Music and Theater Arts faculty work closely together and with outstanding guest artists to create innovative theatrical and choreographic productions, as well as more traditional opera, oratorio, and song. Recent examples range from the opera "Coyote's Dinner" with original libretto and score to "Crowd," a new dance work choreographed by internationally-renowned choreographer Gus Solomons, Jr. (BArch '61 and winner of the first Robert A. Muh Alumni Award honoring an MIT graduate for noteworthy contributions in a SHASS field). "Crowd" was created in collaboration with our dance and composition faculty and featured an original score.

Economics

The research topic most often associated with the MIT Economics Department of the 1950s and 1960s is the analysis of economic growth from a macroeconomic perspective. One faculty member and several former graduate students earned Nobel Prizes for their contributions to this area. Today, economic growth and issues of development are once again attracting many of the leading scholars in the field, and MIT is again in the vanguard. The new wave of research focuses on microeconomics: how specific policies and institutions shape economic growth.

The resurgence of interest in economic growth at MIT has drawn both faculty and graduate students to a

wide variety of topics. How do structures of government, which in many cases were created by colonial powers several centuries ago, affect the growth of market institutions and therefore the rate of growth? What is the role of credit cooperatives in spreading risk and providing incentives for entrepreneurial ventures? How has the expansion of public education in Indonesia had significant pro-growth effects? In what ways does the corporate governance structure in India and elsewhere facilitate the expropriation of resources by small groups of investors and retard the expansion of equity-financed firms? Dissertation research on topics such as public health, the structure of labor markets, and the analysis of tax and expenditure policies further contributes to the broad recognition that MIT is transforming the field of development economics. This kind of research has the potential to generate real improvements in living standards for many inhabitants of developing nations.

Political Science

The MIT Political Science Department emerged at the height of the Cold War, and its initial research focus was strongly shaped by the problems facing the U.S. in the 1950s and 1960s. Faculty did applied research on weapons and military strategy and developed new ways of understanding how people deal with military crises. The Cold War also generated substantial interest in political development, communications, and the technologies of democracy.

MIT Political Science has evolved along with changes in international and domestic politics. The department, in

conjunction with the CIS, now has the nation's leading Security Studies Program, broadly realist in outlook and focused on how countries pursue national interests. More recently, Political Science has developed a strong group in positive political economy, which also draws on faculty in Economics. The group's project is to map the form and politics of democratic institutions and to measure their effects on policy and on the long-term economic and social consequences of policy. Faculty are examining the degree to which legislative decisions reflect the electoral institutions (districts) and legislative institutions (parties) of government; how federalism more often weakens fiscal accountability and leads to high debt levels rather than to efficient sharing of costs and responsibilities; and how uncovering the sources of people's expressed preferences through the use of game theory and social theory helps to explain the development of social and political identity in India.

A complete picture of programs and significant research in SHASS can hardly be described adequately in a short summary. What can be said is that the SHASS research enterprise is rich and diverse and parallels in quality and inventiveness that of MIT's other schools.

I wish to thank Professors Alec Marantz (Linguistics), Peter Donaldson (Literature), Ellen Harris (Music and Theater Arts), James Poterba (Economics), and Joshua Cohen and Stephen Ansolabehere (Political Science) for contributing to this article.♣

[Philip S. Khoury can be reached at khoury@mit.edu]

Testimony Before the House Committee on Science

October 10, 2002

Sheila Widnall

Mr. Chairman and Members of the Committee:

I am happy to have the opportunity to appear before you today to discuss an issue that will have a profound effect on basic research and education in universities and may control the very productivity of American science and technology itself, as well as its contributions to our national security, our economic development and the health of our people; as you recognize, the stakes are very high.

I have submitted a written statement and request that it be entered into the record. I also request that the MIT report entitled "In The Public Interest," which I shall reference in my remarks, and the Annual Report of the President of MIT, Dr. Charles Vest, entitled "RESPONSE AND RESPONSIBILITY: Balancing Security and Openness in Research and Education" be entered into the record.

I am Sheila Widnall, Institute Professor and Professor of Aeronautics and Astronautics at MIT. I am also Vice President of the National Academy of Engineering, a member of the Executive Committee of the National Research Council, and a member of the National Academies' Committee on Science, Engineering and Public Policy. I served as Secretary of the Air Force from 1993 to 1997. So I enter the discussion of basic research and national security from a variety of vantage points.

I appear before you today as Chairman of the MIT Committee on Access to and Disclosure of Scientific Information. This Committee was established jointly by the MIT Provost and the Chairman of the Faculty and

asked to determine if our current policies provide adequate guidance to consider MIT's role in classified research in the context of the twenty-first century: policies governing the conduct of classified research on our campus; policies governing participation of faculty and students in classified programs at Lincoln Laboratory and other cleared facilities; policies governing the access to classified material on our campus; and restrictions on access to research results that flow from industrially-sponsored research. We also examined the emerging regimes of other restrictions – such as the designation "sensitive" – on research disclosure and research materials that fall short of full classification but none-the-less restrict access to and dissemination of research results.

Our report, entitled "In the Public Interest" was published in June and has received considerable notice within the scientific and science-policy communities as well as wide coverage in the media.

There are many issues that our committee did not consider. Our charge was centered on MIT's research policies and on possible changes to these. We did not deal with issues affecting individual faculty, as they consider how best to fulfill their public service responsibilities, or how they choose to communicate their scientific findings through education or publications, or how they manage their laboratories and research groups.

We did not consider the full range of issues faced by this committee and various government agencies; I will, however, as requested in the invitation to appear before you, respond to your

questions from the viewpoint of my committee as well as my own experiences.

One of the gratifying outcomes of 9-11 was the articulation of American values: the recognition that our heroes were the men and women who risk their lives to protect us; the value of our open, democratic society; the worth of the individual. In addressing our charge, our faculty committee focused on balancing the values that govern the operation of a great university: the obligation to perform public service for this Nation balanced with the need to protect the openness and access that supports our educational and research mission.

MIT has a long and distinguished record of public service. Our report documents that record, beginning with its role in developing radar during WWII. That effort established the institutional framework for the participation of the physical science and engineering communities in research related to national security and the relation between open basic research on our campuses and the classified regime that occurs in special laboratories. It also brought into being a scientific advisory committee structure, many holding security clearances, to advise government agencies on the quality of defense research and the identification and the application of new critical research results. Most faculty in the physical sciences and engineering have a detailed understanding of the relationship between their research and teaching and its application through our industrial base to national security. In my case, I

(Continued on next page)

Testimony Before the House Committee on Science

Widnall, from preceding page

understand the relationship between my graduate aerodynamics course and what it takes to build an F22, and I know why we might want to do that.

MIT today manages Lincoln Laboratory in support of the national security mission of the Department of Defense. Many MIT faculty participate in classified research and advisory activities at Lincoln. In addition, many members of the MIT faculty hold security clearances to support their participation in advisory committees to the federal government. We believe that these are important forms of public service performed by MIT. Our committee was quite clear on our willingness to do classified research in the service of the nation on all topics within MIT's expertise.

In balance with this public service mission is our fundamental responsibility to educate the next generation and to pursue the highest quality research for the betterment of mankind. The committee was unanimous in its belief that this – the highest form of public service – requires a free and open campus for both education and research.

In our report we stated, "We believe that MIT, to fulfill its mission, must have an open intellectual environment. Education and scholarship are best served through the unconstrained sharing of information and by creating the opportunities for free and open communication. Such an environment enables students to be exposed to the most current knowledge and allows scholars to build upon and to evaluate each other's work. National security, the health of our nation, and the strength of our economy depend heavily on the

advancement of science and technology and on the education of future generations. The well being of our nation will ultimately be damaged if education, science, and technology suffer as a result of any practices that indiscriminately discourage or limit the open exchange of ideas. Peer evaluation of research methods and findings, an outcome of open sharing and debate within the scientific community, is a crucial mechanism to insure the continued quality and progress of science.

Openness enables MIT to attract, educate, and benefit from the best students, faculty, and staff from around the world. This is especially important, as competence in science and technology has grown throughout the world so that access to research and knowledge outside the United States is critical to our own progress. Over the course of many years, immigrant scientists as well as foreign visitors and students have contributed enormously to the American educational and scientific enterprises. They have enriched our knowledge and culture, promoted the growth of our economy, have become essential contributors in American companies and research laboratories, and have improved the quality of our lives. Many will return to their home countries to become leaders with an understanding of our nation and our values. We believe that no foreign national granted a visa by the U.S. government should be denied access to courses, research or publications generally available on campus.

Our recommendations flow directly from balancing our public service

responsibilities with our belief in the absolute necessity of maintaining an open intellectual environment on our campus.

I will summarize a few of our findings and recommendations that are relevant to your concerns. We recommended:

- That no classified research should be carried out on campus, that no student, graduate or undergraduate, should be required to have a security clearance to perform thesis research, and that no thesis research should be carried out in areas requiring access to classified materials.

- That because there is no consistent understanding or definition of what would constitute "sensitive" information, MIT should continue its policy of not agreeing to any sponsor's contractual request that research results generated during the course of a program be reviewed for the inadvertent disclosure of "sensitive" information. Increasingly, MIT has seen the attempt by government contracting officials to include a requirement that research results be reviewed, prior to publication, for the potential disclosure of "sensitive" information. Such a request implies potential restrictions on the manner in which research results are handled and disseminated, and may also restrict the personnel who have access to this material. The difficulty with this approach is that the term "sensitive" has not been defined, and the obligations of the Institute and the individuals involved have not been clarified nor bounded. This situation opens the Institute and its faculty, students, and staff to potential arbitrary dictates from individual government

(Continued on next page)

Testimony Before the House Committee on Science

Widnall, from preceding page

contract monitors – however well intended. To date, MIT has refused, in all cases, to accept this restriction in any of its government contracts.

- That while we understand that occasionally research findings are classified after the fact because of the importance of the discovery, we believe that this should be a rare event. In the current climate, we may see a desire on the part of contract monitors to more closely oversee the ongoing research with a goal of imposing classification on emerging research results. To be acceptable, we believe that any such actions would also be extremely rare and would require great sensitivity and care to avoid damaging the process of discovery. If this practice becomes common in a field of research, we would recommend that such research not be pursued on our campus.

- That the requirements under the Patriot Act involving personnel, students, faculty, and staff are not consistent with MIT's principles. It is likely that in the current climate, the number of biological agents on the list will grow and the restrictions placed on personnel, physical access, and publication of research findings may grow as well. At some point, MIT may rightfully decide that on-campus research in areas governed by these regulations is no longer in its interest or in line with its principles. We should consider applying a sunset clause to the acceptance of new contracts for research carried out under such restrictions.

- That laws governing export of scientific information and artifacts pose difficult issues for university research in governed areas. MIT should insure

that the designation of fundamental research and public domain, which enjoys an exemption from the need to seek export licenses prior to disseminating information or items, extends to as much of its ongoing research activity as possible, consistent with the national interest. Any formal or contractual restrictions on the open sharing of research results should be accepted only after careful analysis of their effects upon MIT and its research program.

- That research programs designed to respond to national needs may occasionally involve a classified component such as a classified follow-on program to apply the results of fundamental research to the development of systems and/or hardware, or the need to use specialized equipment in cleared facilities to measure material or component characteristics. There are several organizations that can provide access to classified facilities to enable MIT faculty to carry out the classified portions of their research.

- That we affirm MIT's current policy, which does not permit, classified theses. Moreover, we believe that no student should require a security clearance nor require or have access to classified material to perform thesis research. All thesis defenses should be open to the MIT community.

- That the management and oversight of Lincoln Laboratory are major components of the public service that MIT carries out for the nation. In its oversight role, MIT should continue its active management of Lincoln Laboratory to insure that: 1) the research meets MIT standards for independence and

quality, and 2) in so far as possible, Lincoln provides an environment that enables faculty to do research with national security implications.

- That there may be times when rapid near-term access to specialized MIT on-campus facilities and expertise will be required by the nation. Examples of this would be the need for forensic analysis of biological materials, materials preparation, and the use of other facilities and expertise for significant national purpose other than research. Providing this type of assistance may require special procedures for restricted access. We believe that MIT should make such expertise available for a short-time response with a time-definite sunset clause.

- That MIT faculty play important public service roles in areas requiring access to classified materials. To support these activities we recommend that MIT hold security clearances for faculty who require them, and provide off-campus facilities to allow access to classified materials needed to engage in research or public service.

- That MIT should not provide facilities for storage and access of classified materials on the MIT campus. An off-campus site should be provided for faculty to use such material, as required, utilizing the facilities of Lincoln or Draper Laboratories.

The committee was unanimous in its view that now is the time for MIT to articulate its values and establish a clear statement of policy that will ensure open access and free disclosure of on-campus research results and guarantee the openness of our educational environment. We also believe that this

(Continued on next page)

Testimony Before the House Committee on Science

Widnall, from preceding page

statement will be valuable to other universities and others who are dealing with these difficult issues.

Let me share with you some of my personal reflections on the issues before you and respond to the questions you asked. As mentioned above, the physical science and engineering community has 50-years' experience dealing with the relationship between basic research and its national security applications. There is a well-developed institutional framework within government agencies for considering and carrying out the management of these issues. Members of the scientific community are active participants in providing scientific advice to these government agencies as they carry out this mission and in evaluating the quality of the scientific work carried out in this environment.

In contrast, the biological and health science community has little history to guide them through the current debates. As an outsider to this community, I see several emerging needs: that we should identify what portion of the biological sciences needs to be classified; that there needs to be an institutional/agency framework to manage this process; and that there should be a mechanism to involve members of the scientific community in an advisory committee structure to guide these decisions and evaluate the progress of research in these areas. These decisions should not be taken lightly for it is likely that in the areas so identified and so restricted, there will be no research carried out on university campuses involving graduate students and postdocs. I believe that this will significantly hamper scientific

progress in these areas by restricting the free-flowing criticism, replication of research results and vigorous challenge that is an essential feature of the scientific enterprise. But that is the nature of the balance that must be achieved – a decision not to be taken lightly.

Drawing from my remarks, I now focus on your two questions regarding the designation “sensitive” applied to areas of research and the necessity for an open environment for the progress of science.

I believe that the current approach – that focuses on sensitive research as a halfway house of restriction – is doomed to failure. It frames and asks questions that cannot be answered by the people or the institutional structure that asks. It is neither comprehensive nor precise and in its attempt to deal with research after the fact will be an ineffective distraction to everyone in the system. I believe that analysis of the current issue leads to the same conclusion that appeared in the Corson Report issued by the National Academies in 1982: that the right approach to security is to identify precisely the specific areas requiring classification and to build very high walls. This debate within government and university leaders during the Reagan administration led to NSDD189, which states that scientific information is either classified or unclassified and generally exempted fundamental research from security regulations. This distinct boundary was fundamentally clear and effective for many years and this remains our policy today. As I have outlined above, the process of reaching decisions on classification requires a proper

government agency framework and the active participation of the scientific community. What is different is the nature of the scientific disciplines involved, their relation to their industrial base, the time scales and the level of expertise required to apply the discoveries, and the lack of a 50-year working relationship on security issues between relevant government agencies and the biological and health sciences.

Yes, it really is true that science requires an open environment to thrive. Our scientific and engineering productivity flows from our open system of basic research combined with education. While there are excellent examples of classified and proprietary applied research that have grown from this base, their excellence is only guaranteed and sustained by the constant renewal that arises from the criticism and peer evaluation of research scientists and engineers who constitute this open and accessible research base. Cut off from such criticism and challenge, science deteriorates: subject to political rather than scientific judgments, producing fads, junk science, and wishful thinking. Our strong belief is that students must be educated in this open environment to insure the highest quality of their educational experience.

The issues you are addressing are crucial for the future of American science and engineering and the achievement of the benefits for our national security, our economic development, and the health of our people that have flowed from this productive enterprise. I wish you success in your deliberations.♣

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TEACH TALK

Enhanced Conceptual Understanding

David L. Darmofal

Four years ago, I was co-teaching our department's undergraduate course in aerodynamics, 16.100. This subject is taken by about 40 students each year split between juniors and seniors. My faculty cohort and I decided that the final exam should be different from the exams we had given in previous semesters. Our old exams were often variations on homework problems, "plug-and-chug," or "prove that" questions. This time, we felt we wanted to test the students' ability to integrate concepts and apply them in a more complex, open-ended problem, i.e., the type of problems they would face as practicing engineers. Though we had the best of intentions, the final exam was an unqualified disaster. Students resoundingly said that it was the toughest exam they had ever taken at MIT. Many students and, as a result, the faculty were clearly shaken by the exam.

Although we thought our students were achieving a deep level of conceptual understanding through our teaching, they were not. As a result, in the final exam, we assessed skills which the students did not have a good opportunity to develop through the subject's pedagogy. Since we felt strongly that conceptual understanding was a primary goal in our subject, we needed to change our teaching.

A New Pedagogy

Conceptual understanding is often hindered by previous knowledge and/or experiences which may conflict with the new knowledge. In recent years, faculty throughout MIT have changed pedagogy seeking to improve conceptual understanding [Breslow, L., "Educational Innovation Moving Ahead at Full Speed," *TeachTalk*, *MIT Faculty Newsletter*, Vol. XIII, No. 1, September

2000.] We chose to implement in-class concept questions following Mazur [Mazur, E., *Peer Instruction: A User's Manual*, Prentice-Hall, Upper Saddle River, NJ, 1997.]. In a typical class, two-to-three concept questions will be given to students with time for individual reflection following each question. After a check to see how well students have understood a question, small group discussions may be held. In addition, the instructor will usually clarify misconceptions and lead students in further exploration of the concept. In 16.100, we measured class response through PRS [Personal Response System, PRS, <<http://www.educue.com>>], a handheld personal response system. PRS has several advantages over hand raising or flash cards, including anonymity of student responses and the generation of assessment data to analyze aggregate performance.

Our experience with concept questions has shown that students must have some engagement with the material prior to class. In 16.100, we give reading assignments and (graded) homeworks which are due prior to in-class discussion. By encouraging self-directed learning through pre-class homework, students are better prepared for class and faculty can then focus on the important concepts and misconceptions. I personally believe this adds significant value to the classroom experience by allowing our faculty to do what they do best.

In addition to modifying our pedagogy, we have also modified our exams from a written to an oral format. While written exams can only analyze the information which appears on paper, i.e., the final outputs of a student's thought process, an oral exam is an active assessment which can provide greater insight into

how students understand and relate concepts. Also, oral exams are adaptive to each student. If a student is stuck or has misunderstood a question, the faculty can help the individual. As opposed to a wasted assessment opportunity, the dynamic adaptivity of an oral exam raises the likelihood of an effective assessment. Finally, practicing engineers are faced daily with the real-time need to apply rational arguments based on fundamental principles. By using oral exams, we can directly assess this ability.

The Impact

Quantifying the impact of pedagogical change on learning is a difficult task. Our approach is to take data from a variety of sources and draw our conclusions from the aggregate. While any single source is suspect, taken together, the results become convincing.

The generation of lift on an airfoil is filled with many misconceptions due to the (usually inaccurate) folklore regarding how airplanes fly and is further complicated by the knowledge gained in previous courses. On the first day of the fall 2000 and 2001 semesters, I gave the students a survey on aerodynamic concepts which included an open-ended question on lift generation. For the fall 2001 semester, the students were also asked in the mid-term oral exam to explain lift generation. In Figure 1, the responses have been divided into five groups. The momentum change and streamline curvature response is arguably the best answer but only 10% of the students offered this explanation at the beginning of the semester. For the second response, students correctly explained that a net pressure difference is acting on the airfoil to produce lift, but

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Enhanced Conceptual Understanding

Darmofal, from preceding page

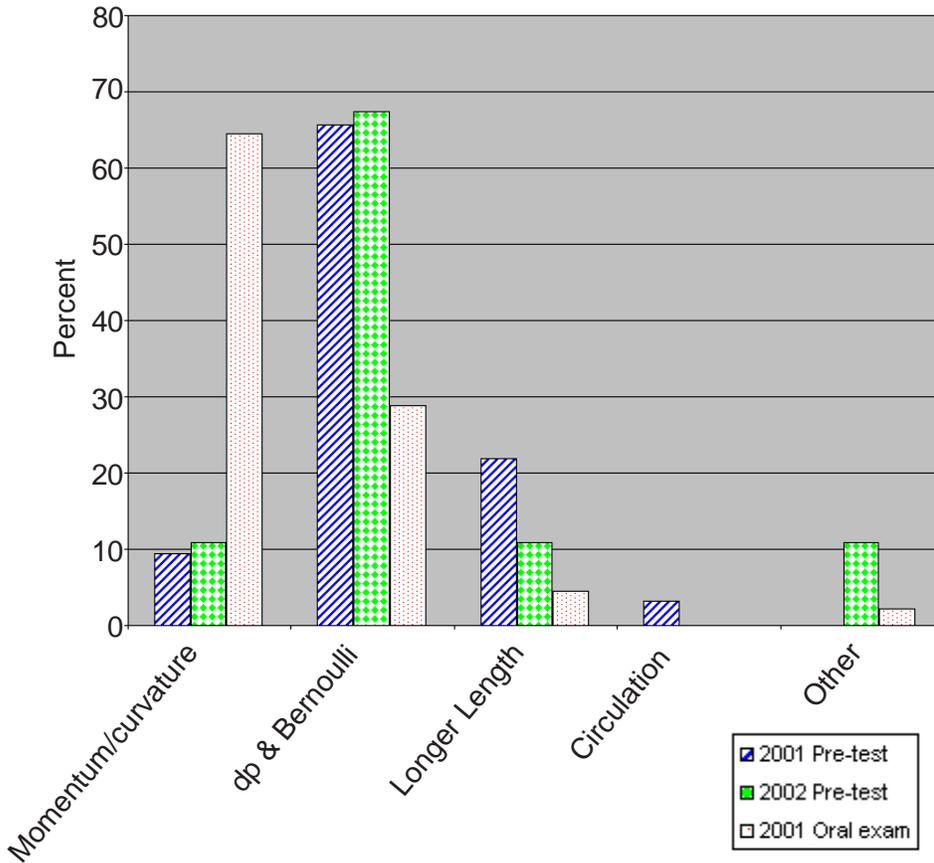
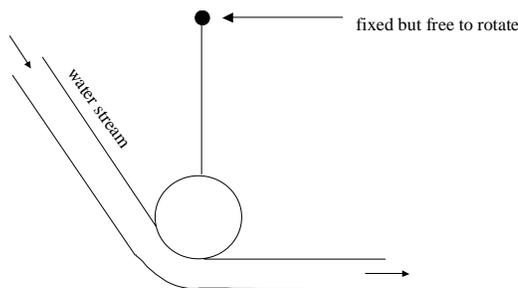


Figure 1. Lift generation on an airfoil. Preconceptions compared to oral exam assessment.

then offered the Bernoulli effect as the underlying cause of this pressure difference (which is not really true). At the beginning of the semester, this was the most popular answer, at over 60%.

We use a series of concept questions concentrating on understanding lift generation through momentum changes and reaction forces. The first question involves the impingement of a water jet



Given the water behaves as shown above, which direction will the cylinder rotate when the stream makes contact with the cylinder?

- (a) Clockwise
- (b) Counter-clockwise

Figure 2. Flow turning and momentum change concept question.

on a cylinder (see Figure 2). Although many students believe the jet will cause the cylinder to be propelled away from the stream, in actuality, the object will rotate into the stream. A simple momentum balance leads directly to the connection between lift generation and momentum change—our intended result! When we use this question, we include an in-class demonstration which clearly demonstrates the cylinder being drawn into the stream. As evidenced in Figure 1, the active-learning pedagogy has made a substantial impact by the mid-term exam in fall 2001, with an over 60% response rate for the momentum-based lift explanation.

We have also assessed the students' ability to integrate several concepts using a question from the disastrous fall 1998 final written exam as the basis for the 2001 final oral exam. While a significant shift in performance has occurred (see Figure 3, next page), several caveats exist. In particular, in the written exam, students had several other questions to answer and could adopt the strategy of spending less time on this specific question. Thus, we believe that the apparent performance gains were in part due to the more effective assessment strategy.

Student reactions to the new pedagogy have been overwhelmingly positive. In Figure 4 (next page), end-of-semester student evaluations from fall 2001 clearly show a dramatic improvement in effectiveness over fall 2000 for the lectures, in-class exercises, and assignments. We note that in both years, we used active learning but in fall 2000, our pre-class assignments were not difficult and required little student engagement of the material to answer. Student comments also show that an initial opposition to the new learning

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Enhanced Conceptual Understanding

Darmofal, from preceding page

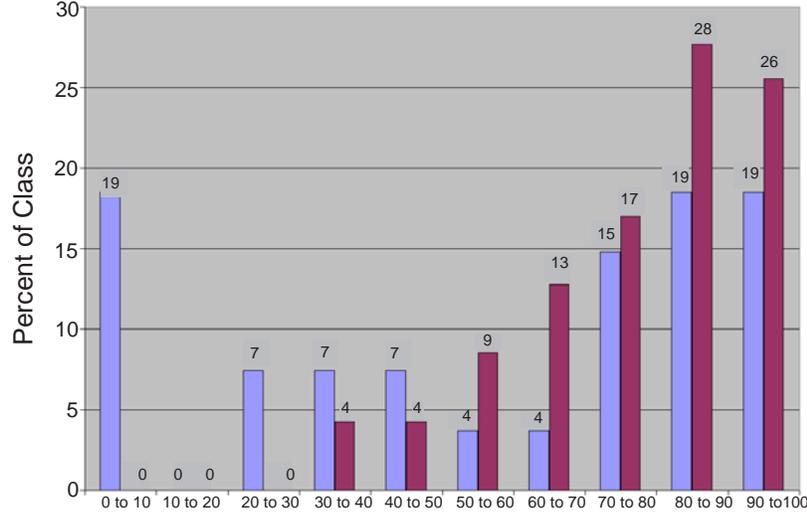


Figure 3. Comparison of student performance on the same conceptual question from 2000 written exam (light colored) and 2001 oral exam (dark colored).

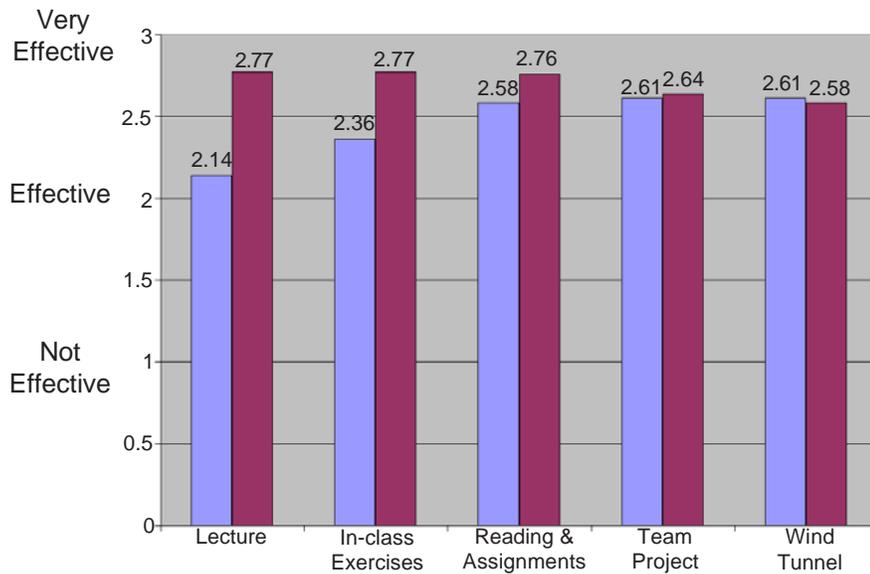


Figure 4. Comparison of 2000 (light colored) and 2001 (dark colored) student evaluation of course pedagogy.

style fades as students recognize the effectiveness of the new approach. For example,

- I was initially opposed to the idea that I had to do reading & homework before we ever covered the subjects. Once I transitioned I realized that it made learning so much easier!!*

- I was skeptical at first of new techniques like PRS, hw on material that hasn't been learned in lecture. In the end, it worked out*

very well. This has been a course where I really felt like I got my money's worth.

- I really like the format of the class, I think it's actually a very good way to format a course. At first I didn't like how the homework was really tricky and it always came before we went over the material in lecture, but after a little bit I didn't mind it.*

- This is how all MIT classes should be. Other professors should come by and learn your teaching techniques.*

Closing Thoughts

Since the final exam debacle a few years ago, my teaching and, I believe, student conceptual understanding has been greatly improved. The last few years have personally been very rewarding as my classroom has become an active environment with a focus on conceptual understanding.♣

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Language, Film, and Technology Workshop Aligns Humanists with Cambridge-MIT Institute

Douglas Morgenstern, Alex Chisholm, Edward Baron Turk, and Elizabeth Garrels

Engineers and economists may have been the architects of the Cambridge-MIT Institute (CMI), but humanists from both sides of the Atlantic have clearly made known their intentions to be included in this important collaborative effort.

As a followup to a visit to the University of Cambridge (CU) by several members of MIT's Foreign Languages and Literatures Section in January 2002 and additional spring and summer visits to Cambridge by members of MIT Comparative Media Studies (CMS), faculty and administrators from the University of Cambridge's Faculty of Medieval and Modern Languages, Oriental Languages, Centre for Applied Research in Educational Technologies, and the Centre for Research in the Arts, Social Sciences, and Humanities attended a workshop at MIT in late September that prepared the way for several joint efforts and projects. The *Workshop in Language, Film, and Technology* was hosted by both Foreign Languages and Literatures (FL&L) and Comparative Media Studies and included presentations as well as class visits on subjects ranging from online projects in French, German, Spanish, and Japanese to Web archives dedicated to the study of Shakespeare and *Moby Dick*, to the history of comics in the U.S. and the design of computer and video games in education.

The September workshop was, by size and scope, the largest CMI workshop to be hosted within SHASS (School of Humanities, Arts, and Social Sciences) thus far. The two participating faculties found that, in spite of the marked differences between their institutions as well as their language programs, they had much in common. The interest and desire to explore the current and potential uses of a wide variety of media – from audio to video to interactive – in research and education across a wide variety of disciplines – from teaching language to exploring film history to understanding globalization – proved an important element of many presentations and discussions. Indeed, one of our goals in

planning the workshop had been to demonstrate the strong coupling of “theory” and “practice” in the way we at MIT develop content and pedagogy for use in our media projects.

CU faculty were particularly impressed with both the degree to which the humanities and technology development are integrated at MIT and the ease with which MIT students engage in team work, both in CMS research groups and in FL&L classrooms. For example, in an intermediate French class that works with *Cultura*, a telecollaborative project that joins students with their counterparts at a university outside Paris, CU visitors witnessed students explore online archives and cooperate to discover underlying cultural patterns that form the foundation of each culture's perspectives on social, psychological, political, and moral issues. In an intermediate Spanish class, visitors saw several teams of MIT students working (all in Spanish, of course) with audio, photographic, and digital video segments of a Spanish horror film as a prelude to developing hypotheses about its structure and content.

Participants agreed that there were both real interest and practical justification for planning CU-MIT faculty collaborations in terms of pedagogical materials development and research. For example, CU French teachers will pursue the idea of spinning off a three-way project using the *Cultura* framework, while German faculty will explore ways to use MIT's *Berliner sehen*, an interactive video archive, to develop CU-specific teaching tools. CU students will participate in the MITUPV Exchange, an ongoing online multimedia community which currently links MIT, the University of Texas-Austin, and Spain's Polytechnic University of Valencia; in addition, a CU faculty member will shoot new footage in Spain, adding an important dimension to MIT's *Immigrant Voices* video project. CMS's Virtual Screening Room, a project that explores the theory and practice of film editing, will provide an

opportunity for CU faculty to enhance their jointly-taught course in “contemporary European cinema.”

Apart from individual projects, CU has expressed interest in MIT's MetaMedia Project, a digital archive platform for collaborative teaching and research across many disciplines. We anticipate that these efforts will lead to results of value to the greater academic community, such as a proposed electronic multimedia monograph series that would include introductory essays, carefully-edited print versions of commonly-taught texts, contextualized portions of films, and resources to enhance the critical capacities of undergraduates.

We expect that the transfer of skills and methodologies between both institutions can take place among students as well as between faculties. CU participants noted the excellent integration of CMS graduate students in project development and the success of the UROP model in general at MIT; they would like to see which features and structures are exportable to Cambridge. A first step will be to send UROP students to CU through CMI, where they can help train their undergraduate counterparts. Faculty visits and exchanges, as well as a series of planned inter-university conferences on topics such as “The City and Film” and “Cultural Consequences of the 1929 Wall Street Collapse,” will provide a means for effective transfer of knowledge and skills and for the enhancement of our respective programs. Finally, beyond the possible collaborations between the participating counterparts at CU and MIT, an additional positive outcome of the September workshop was that FL&L and CMS strengthened their ties, which augurs well for the continued collaboration of these two academic groups within SHASS.♣

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Research Database Provides Entire Institute Information on Faculty Research Projects

Scott C. Jensen

[Scott Jensen, Assistant Director for Information Services, MIT Corporate Relations, explains updates and innovations to the OCR Knowledgebase]

Anyone at all familiar with the Institute knows that MIT has one of the largest and deepest pools of faculty talent and expertise ever assembled on one campus. While this is especially true in the areas of technology and economics, topics of interest to the MIT faculty cover a much wider range than what is seen at first glance. Specialties ranging from music, architecture, sociology, psychology, and history – to name a few – are all represented through the expertise of some portion of the MIT faculty and research staff. While much of this expertise is demonstrated by the many ongoing research projects, there is a great deal of additional knowledge and talent involving faculty and staff teaching, their consulting and involvement with startups and outside corporate interests, and even their hobbies and personal interests.

Trying to keep track of all of this knowledge and expertise has become no small task. With MIT faculty, scientists, and researchers involved in so many different areas of research, staying current with who's doing what and who is an expert in a specific field has become a very non-trivial goal. In order to make this a manageable task, about five years ago the Office of Corporate Relations developed a database of faculty expertise and research project information. Known as the OCR Knowledgebase, this database stores information about the faculty, the DLCs (department/lab/center), and the research projects on campus, and provides that information in various summary and detail report formats through a searchable interface. The Knowledgebase was

originally developed to provide the Corporate Relations Officers with a tool to help them match faculty members and areas of research with outside corporate interests, but access to the Knowledgebase has since been opened up to the entire MIT community via the Web: <http://knowledgebase.mit.edu/>

This Website is available to any client on the MIT network, and provides an interface that the MIT community can use to find such information as a faculty member's name, title, contact information, any DLCs with which they are affiliated, a brief overview of their educational and biographical history, and a description of their interests and expertise. It also contains references to news articles that involve the faculty member, as well as a list of any research projects for which the faculty member is the Principal Investigator (PI) or Co-Investigator (CI). People listed in the Knowledgebase include professors, lecturers, researchers, scientists, scholars, some graduate students, and even some staff members (over 4000 names). Basically, if the person is involved with research in some way, they should be listed in the Knowledgebase.

The section of the Knowledgebase that stores information regarding research projects on campus (often referred to as the RaMIT database) maintains data on each research project's affiliated DLCs, PIs and CIs, abstract, index terms, and other associated information. Information regarding each DLC (mostly a textual description and list of associated faculty) is also maintained in the Knowledgebase.

All of this information is maintained by a full-time administrator of the system, Ms. KC Klingensmith, who spends a great deal of time keeping the information in the Knowledgebase current, correct, and consistent. In addition, faculty are

strongly encouraged to keep their own data up to date (see URL above). In the detail pages of both the faculty and RaMIT sections, there are buttons marked "Enter Update Mode." Clicking on these buttons will cause the current record information to be redisplayed in a form page. Once the user has updated the information on the page, he or she can submit the changes to the Knowledgebase, where it will be verified and entered into the production database.

The Knowledgebase system is always evolving, and that's certainly going to be the case in the next few months. As part of the development of a new office-wide information system currently underway, the Knowledgebase is going to be almost completely re-implemented. The graphical motif of the pages will be improved, more information will be maintained regarding the faculty, DLCs, and research projects (and in a much more structured format), and more report formats will be available as output options (such as faculty CVs – the number one requested enhancement to the system). Data stored in the Knowledgebase will also be reflected in the campus Data Warehouse, so other departments will be able to access this information using the standard query tools (Brioquery, etc.).

Our goal is to make the Corporate Relations Knowledgebase the one-stop-shopping solution for any and all faculty expertise and research information on campus. After the planned changes and improvements come to pass, we believe the new Knowledgebase will meet that goal. Both myself <jensen@ocr.mit.edu> and KC <kc@ilp.mit.edu> urge you to send us any questions, comments, or suggestions you have for the system. Hopefully, we can make the OCR Knowledgebase a tool worthy of the talent and expertise it reflects.♣

Letters

Theory of Relative Thoughts

I read with amusement/horror Lori Breslow's article in the *Faculty Newsletter* [Vol. XV, No. 1] where it was hypothesized that there is a true debate on the differences between teaching and research. I believe teaching and research are not different, for they must each be driven by passion if they are to thrive. However, I would like to observe that it seems all too often that in one case, there is the ability to be free with your mind and the minds around you, to boldly geek where no geek has geeked before . . . ; and in the other case: there is endless review by committees composed of perhaps well-meaning but relatively hopelessly constrained colleagues. In one case there seems to be a world that says "yes, yes, yes, give us more new exciting ideas!" In another case there seems to be a world that says "ask not what you can do for us, do only what we tell you to do." How many more arguments do you want for why perhaps most of the best and brightest minds focus on freedom? Give me passion or give me research!?

Personally, I believe I have achieved a pretty good balance between teaching and research – and I believe it's because I happen to drive a velvet bulldozer. My blade is lined with pillows, although sometimes I must use the ripper (see <http://www.caterpillar.com/> if you need translations). Others are not so fortunate (or foolish some would claim).

As a case in point, recently I sought to create a class which transcended departmental boundaries where students would learn a design process that was good for mechanical design and manufacturing, yet also include design of art, *and* how this process might be applicable to problems such as how to achieve peace in the Middle East. I called it "Paths to Peace" and spent a lot of time with some of my Institute colleagues to create a well-thought-out syllabus and posted it on the Web (<<http://pergatory.mit.edu/>>2.993). A student e-mailed the department about what a fun course this would be. The e-mail said the students would get to work alongside a real practicing artist and get to use the Hobby

Shop's new waterjet cutter (which was paid for by companies and agencies excited about the course). Almost immediately, I received a very caustic nastygram from a colleague about how this was not a real course, etc. This started a wave of "yeah, what is this stuff . . ." e-mails. They stopped when I pointed out that the attacker, a professor trained in the scientific method, *never* even took the time to visit the course Website to learn the details. The professor did not even have the courtesy of e-mailing me personally first with their private concerns. I responded relatively nicely (we should all know now that e-mail draws vacuum, which is why you often get rained on when you send it). In the end, I believe I will prevail by means of the work students will do. If I do not, well, I will at least have tried. Meanwhile, my colleague is calling for new committees to be formed to review all teaching proposals lest evils like I tried should ever slip through again! I guess since he has no research funding he has plenty of time to spend derailing people who might have potentially new, exciting teaching ideas. Meanwhile, I must say I am heartened by the numerous private e-mails I received from colleagues with lively research programs who really loved the proposed course. They at least reviewed the Website! QED.

And to add to the potential paradox of reciprocity, I earlier had found myself in the less than desirable position of space committee person in charge of seeing current-use teaching space, used only one semester per year as teaching space and the balance as a storage area for the class, converted to full-time research space for a junior faculty member. Hell hath no fury like a senior faculty member whose space has been converted . . . and the scars, both self- and externally-inflicted from this encounter, may never heal.

And what about sports? As a rabid snowboarder and SCUBA diver, I wish I had more time for these pursuits, yet they seemingly take me away from geek time. Yet when I do not exercise my body (*and* mind in different ways), my geek circuits do not function as well. We have athletes that

have poor grades and do no research, and we have all-American athletes that are also top geeks. Are we forever cursed to be wrong whenever we generalize? I guess Gauss rules!

A final paradox may be my own awakening as to the thought processes involved in the humanities and those of engineering and science, which brings us full circle to the "Paths to Peace" course. Indeed, perhaps the evolution of research in physics has the most to teach us about the teaching/research quandary. At times we professors are teachers, and at other times we are researchers, although there are those who would claim that teachers and researchers are different and there are others who would claim they are not. Was it not Bohr who was instrumental in resolving the wave/particle duality quandary? Perhaps thought itself, the quest for understanding that is not necessarily data driven and yet when it occurs can be used to explain much data, that is the string with which teaching and research can be bound? It might take a seriously silly super string to make this happen, but I believe if we step back from the knotty debate of what is teaching and what is research, stop trying to tie up loose ends, and instead let passion be the focus of our universe, we will be able to coalesce our thoughts into a single idea and BANG, we will have a big revolution in the catalysis of thought!

Hmmmmmm, would it not be just nifty if everything boiled down to just passion, for from passion springs thought, and from thought springs life itself and the reason for living it to its fullest!

How is MIT to realize this potential reawakening? Broadly, eliminate half the requirements, and starting Junior year, let students take whatever they want, and let professors teach whatever they want. Realistically there are a lot of details to be worked out, but in the end passion will rule!

Sincerely (and still hyper geeked!),

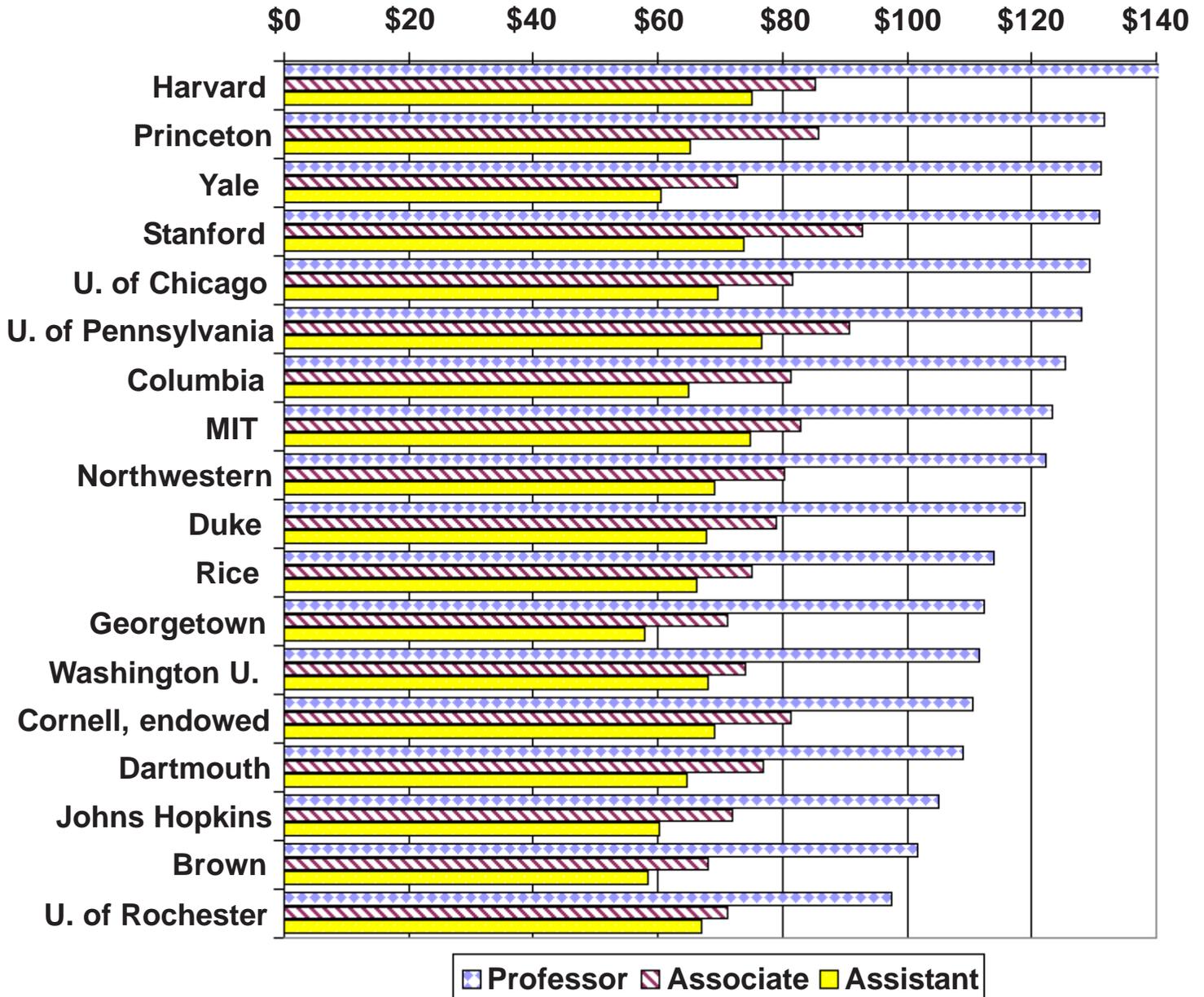
Alex Slocum
Professor of Mechanical Engineering

M.I.T. Numbers

Average Faculty Salary By Rank

Selected Institutions (FY2002)

(thousands of dollars)



Source: Chronicle of Higher Education