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MIT Faculty Newsletter

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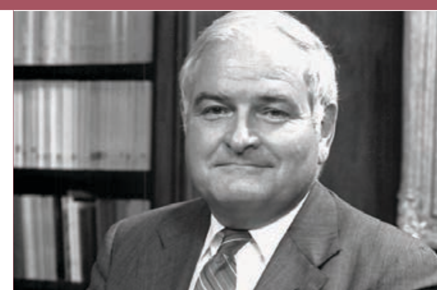
in this issue we feature new Chair of the Faculty Susan Silbey's first offering, "The Fundamental Challenge Facing Higher Education Today," (below); commentary by Haynes Miller on the closing of Senior House, "A Hole in the Flag," (page 9); and our occasional Teach Talk article, "How Deeply Are Our Students Learning?" (page 10).



Former MIT President Paul Gray (1932-2017)

From The Faculty Chair

The Fundamental Challenge Facing Higher Education Today

Susan S. Silbey

AS WORD OF MY FORTHCOMING service as Chair of the Faculty traveled, several colleagues offered congratulations. Others offered commiseration. A few asked me what I wanted to accomplish. This was provocative! After only two months on the job, I know that there is not much free space for extended contemplation and creativity. I am, however, obliged to write regular columns for the *Faculty Newsletter* and I have decided to use these spaces to think with my colleagues, perhaps to be provocative myself, about what we do as teachers and scholars and the challenges presently confronting higher education.

A few years ago, several of our colleagues asked me for what they described as cultural help. With almost exactly the same words, they told me, "My students are brilliant, creative, can do anything, but

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A Brief History of the *MIT Faculty Newsletter* as it Marks 30th Anniversary

John Belcher and Jonathan King

THIS COMING YEAR WILL MARK the 30th anniversary of the "zeroth" issue of the *MIT Faculty Newsletter* (FNL). The FNL was founded in response to the decision of then Provost John Deutch to close the Department of Applied Biological Sciences (ABS), without following the *Rules and Regulations of the Faculty*. Absent a faculty senate or equivalent deliberative body, there was no mechanism at the time for faculty to discuss key issues freely with each other. Indeed the Editorial Board of the FNL, elected only by faculty, is still the only committee at MIT where faculty discussions can occur without administrative intervention.

During the ensuing years, the *Newsletter* has provided a forum for expression of faculty concerns and views, a major channel of communication

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Editorial

DACA Issues; Grad Housing Struggle; Steve Lippard Retirement; Verghese Gift; Call for Nominations

DACA/Other Immigration Issues

THE SUMMER MONTHS HAVE BEEN dominated by President Trump's pronouncements on various policy issues of national significance. Most immediately relevant to MIT is the fate of immigrants in our MIT and Boston area community. President Reif issued a strong statement in support of those at risk in the DACA (Deferred Action for Childhood Arrivals) program; Chair of the Faculty Susan Silbey circulated a letter from our colleagues Phil Sharp and Tom Kochan calling for continuing support of MIT custodial staffer Francisco Rodriguez, who is currently in U.S. Immigration and Custom enforcement custody. MIT is providing legal support in his case.

Our faculty needs to support these individuals and groups in every way possible. Contributions to the Rodriguez defense

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fund can be made at: ***https://www.gofundme.com/helpFranciscosFamily***.

Graduate Student Housing

This is the 30th anniversary of the publication of the *Faculty Newsletter*, the major campus outlet for the independent voice of the faculty. Over the decades, the pressing issues have changed. A major problem in the past few years needing our attention has been the failure of the MIT administration to provide adequate affordable housing, accessible to campus, for graduate students. MIT has the land, the need, and the financial resources to reduce the onerous housing pressure on thousands of our graduate students who must find somewhere to live further and further away from campus. The intense commercial development in Kendall Square is not only pushing long-term residents out of the community, but also forcing many hundreds of graduate students to seek affordable rentals at greater and greater distance from campus. The shortage of graduate housing has been a consistent concern of graduate students, postdoctoral fellows, and junior faculty, as reported in many letters and articles in the *Newsletter*. The FNL Editorial Board opposed the MITIMCo (MIT Investment Management Company) decision to use our own East Campus to build commercial office buildings and market-rate housing, rather than substantial graduate student housing and academic buildings. We can't ignore our responsibility to our graduate students.

More recently MITIMCo has purchased the Department of Transportation Volpe Site (John A. Volpe National Transportation Systems Center) adjoining Broadway in Kendall Square. This provides another opportunity to build the needed graduate student housing. Unfortunately that goal is absent from the MITIMCo proposals to the Cambridge City Council. Again, our graduate student needs are ignored.

This spring, the MIT Graduate Student Council (GSC) again took up the issue of inadequate housing. They proceeded carefully and thoughtfully, collecting further data on housing needs from their membership, investigating municipal zoning, and came up with a concrete need for more than 1400 additional units. The GSC voted 36 to 2 to proceed with a zoning petition to the Cambridge City Council that would call for MIT to build 1800 affordable housing units. Their engagement was a model of responsible leadership. Just prior to submitting the petition, a delegation of GSC leaders met with representatives of the MIT administration to inform them of their plan of action.

Rather than appreciating the initiative and civic engagement of the GSC, the MIT and MITIMCo representatives expressed sufficient hostility to this effort so that the GSC leadership backed off from submitting the petition. Instead of increased housing, Chancellor Barnhart offered to constitute another Working Group to examine graduate student housing needs and prospects. Of course, the prior MIT Clay Commission had already had innumerable meetings on the same subject ("The Current East Campus Plan Still Needs More Grad Student Housing," *MIT Faculty Newsletter*, Vol. XXVII No. 3, January/February 2015.)

On their own initiative, a group of graduate students who are not GSC officers decided to go ahead and filed the petition on August 14, which will be heard by the Cambridge City Council and its Ordinance Committee. The petition is supported by Cambridge community groups who have long been concerned over MIT's inadequate response to graduate student housing, because it increases the difficulty for other Cambridge tenants to afford to stay in their apartments. "The graduate student effort should be celebrated by Cambridge officials, especially those who truly understand the housing crisis in Cambridge," said City Councilor Dennis Carlone (quoted in *Cambridge Day*, August 14, 2017). "The submitted petition very much matches what many on the council know is an essential part of easing the housing squeeze in our neighborhoods, especially for families and people in need." More detailed accounts of these dilemmas, challenges, and clearly problems are covered in prior FNL articles, for example, "MIT Construction Plans Continue to Undervalue Graduate Student Needs," *MIT Faculty Newsletter*, Vol. 28 No. 1, September/October 2015.

Steven J. Lippard

One of the core members of the FNL Editorial Board for many years has been Steve Lippard, former Chair of the Department of Chemistry, National Medal of Science awardee, and a staunch advocate for the role of faculty in maintaining MIT's key contributions in national scientific and educational needs. Steve was deeply attentive to the needs of faculty, students, and staff in maintaining an optimally productive and supportive academic and scientific environment. Steve is moving to Washington, DC to be closer to his family. We will miss him and wish him all the best in his new life.

Verghese Gift

We are delighted to announce a generous gift from former *Newsletter* Editorial Board member George Verghese and his wife Ann, in honor of George's parents, George Verghese Sr. and the late Mariam Verghese, both of them science teachers all their adult lives. This gift will allow the FNL to organize a number of activities, including timely forums addressing pressing issues before the MIT community. Our deepest thanks to George and his family.

Call for Nominations

This is a call for nominations to the *Newsletter* Editorial Board. All nominees will be reviewed by the Nominations Committee, and faculty-wide, electronically-based elections are planned for later this fall. Nominees should give evidence of commitment to the integrity and independence of the faculty, and to the role of the *Faculty Newsletter* as an important voice of the faculty. Please forward all nominations to *fnl@mit.edu*. Nominating faculty should include, both for themselves and their nominee, full name, department, Institute address, phone number, and email address.

Editorial Subcommittee

A Brief History of the Faculty Newsletter
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among the faculty, and a means for candid debate on difficult issues. The primary guiding principles have been to provide open access for faculty and emeritus faculty to express views on issues of concern through control of editorial policy by the faculty Editorial Board, independent of influence by the MIT administration. Areas where the independence of the *Newsletter* have been important include the first public release, on our Website, of the report on the "Status of Women Faculty at MIT"; the publication of the Special Edition *Newsletter* devoted to responses to the Report of the Task Force on the Undergraduate Educational Commons, to which more than 40 faculty contributed; exploration of health insurance, pension, and retirement issues; compacts with foreign governments; minority recruitment and promotion; and provision of affordable graduate student housing.

We believe it is still instructive to reflect on the ABS case. On January 6, 1988, faculty members of the 43-year-old Department of Applied Biological Sciences, then Course 20, were informed by the MIT administration that the department would be phased out over the course of the coming 18 months. The department at that time consisted of about 200 members, including 24 faculty, 86 graduate students, plus undergraduate majors and support personnel. In a subsequent article in *The Boston Globe* of February 2, 1988, MIT officials were quoted as saying that the plans to phase out the department arose "... because it is not meeting the intellectual standards expected of a department at MIT. . ." The following paragraph is from the same article:

"While no jobs will be immediately lost, MIT officials said some tenured and non-tenured faculty may end up leaving the Institute. They said "every effort" would be made to place tenured faculty in other departments, but no guarantees have been extended to faculty, or to secretaries and other support staff. Four non-tenured assistant professors may lose their jobs when the current contracts expire. Graduate students in the department will be allowed to finish their degrees."

Areas where the independence of the *Newsletter* have been important include the first public release, on our Website, of the report on the "Status of Women Faculty at MIT"; the publication of the Special Edition *Newsletter* devoted to responses to the Report of the Task Force on the Undergraduate Educational Commons, to which more than 40 faculty contributed . . . .

The response to this disbanding of the department was immediate and overwhelmingly negative. Graduate students in the department circulated a petition with over 110 signatures, maintaining that statements by the administration in the *Globe* as well as those ". . . appearing in *Science* and in other scientific journals seemed to publicly label the faculty and students as second rate. The question is not only whether MIT will award degrees to current students, but whether those degrees have been discredited, said a research associate who had gotten a graduate degree from the department. . ." [*The Tech*, February 19, 1988]. At the regularly scheduled Institute faculty meeting in February, every faculty member who spoke deplored the decision-making process used in disbanding the department. "Professor Gerald Wogan, the head of the department, read a letter from the department faculty which expressed 'disagreement with the decision' and 'disappointment with the surprising process' by which the department was disbanded. The letter said the process lacked 'due process and adequate review' and noted that the faculties were not given 'the opportunity to respond professionally and effectively to criticism.'" [*The Tech*, February 19, 1988].

As a result of the March faculty meeting, an *Ad Hoc Committee on Reorganization and Closing of Academic Units* was formed whose members were Glen Berchtold, John Essigmann, Morris Halle, Henry Jacoby, Phillip Sharp, Arthur Smith, and Sheila Widnall (Chair). The complete report of this committee was distributed to the faculty prior to the May 18, 1988 faculty meeting. The conclusions of that report are online at ***web.mit.edu/jbelcher/www/ABS/***, and we quote two of the paragraphs from those conclusions.

"It is the view of this committee, and we believe of the faculty at large, that a key to the success of the Institute his been the maintenance of a system of shared governance. Few of the MIT faculty see themselves in an employee-employer relationship with the Administration. Rather, most feel that the Administration and faculty share a joint responsibility for sustaining the excellence of the Institute. They expect that, when important choices arise about mission or internal organization, they will naturally be involved in the process leading up to decisions and in the planning of implementation.

. . .

"Aside from the issue of shared responsibility, a source of concern in this case arises from the collective regard of the faculty for one another. It is the perception of the faculty that members of ABS were poorly treated in the process: the unfavorable publicity that impacted their careers, the lack of understanding and communication by the Administration as to the nature of the Institute's commitment to their careers, the lack of consultation prior to the decision, and the announcement of the decision without a detailed plan for assuring the continuity of the careers of the faculty. This is not acceptable treatment of faculty members at MIT by its administration. The incident raised apprehension in the minds of many about the meaning of tenure and the obligations to junior faculty, other MIT personnel and students. We believe the faculty needs a clear statement on these issues and below we make recommendations to this effect."

One of the lasting results of the ABS closing was the fact that the changes in *Policies and Procedures* recommended by the Widnall Committee were subsequently adopted. In the merger of the Mechanical Engineering and Ocean Engineering Departments, these procedures were carefully followed, but few current faculty members know the history that led to the adoption of those procedures.

The second lasting change (at least so far) resulting from the ABS closing was the founding of the *MIT Faculty Newsletter*. At the time of the dissolution of the ABS department, MIT faculty members preparing a petition calling for a reversal of the administration's actions had difficulty in circulating the draft broadly due to the unwillingness of the administration to make faculty mailing lists available. In addition, with the faculty meeting agenda set and the faculty meeting chaired by the President, fully open discussion was not easy. The FNL emerged as an effort to establish open lines of communication among faculty. In the zeroth issue of the *Newsletter*, which is online at ***mit.edu/fnl/vol/archives/fnl00.pdf***, Vera Kistiakowsky wrote:

"A group of faculty members which has been discussing the recent events concerning the Department of Applied Biological Sciences has concluded that difficulty in communication prevents faculty consideration of the problems except in crisis situations. There exists no channel for the exchange of information between faculty members for the discussion of problems at MIT, since neither Tech Talk *nor the faculty meetings serve these purposes. Therefore, we decided to explore the desirability of a newsletter, and one purpose of this zeroth edition is to see whether there is support for such a publication."*

There was significant support for such a publication, and the subsequent 29+ years of issues of the *Newsletter* after the "zeroth" issue can be found in the *Newsletter* archives. Initially the *Newsletter* was supported by contributions, but given that the faculty brings into MIT a large amount in research income, it seemed reasonable to the first FNL Editorial Board that a tiny fraction of that be returned directly to the faculty to finance the *Newsletter*. It was a full nine years after these origins that President Vest formally agreed to support the publication costs and a salary for the managing editor of the *Newsletter*. This battle has had to be fought continually in the years following.

For the first 20 years since its inception, the *Newsletter* was maintained by a volunteer Editorial Board, over time involving more than 30 members of the faculty from all Schools of the Institute. Subsequenlty, we moved to a more formal nomination process, and direct election of Board members by the full faculty. (See a call for Editorial Board nominations on page 3 of this issue.)

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During this period there have been some efforts by some administrations to end or limit the publication of the FNL. One case is described in "The Saga of the Struggle for Survival of the Faculty Newsletter" in the March/April 2007 issue at ***web.mit.edu/fnl/volume/195/me.html***.

The *Newsletter* has come to be widely read, not just at MIT but outside as well, through the online edition at ***web.mit.edu/fnl***. The FNL Website also can potentially serve as a forum for discussion of national and international issues. With the support and involvement of MIT's faculty, the *Newsletter* will continue to play an important role at MIT and beyond.

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Jonathan King is a Professor in the Department of Biology and *MIT Faculty Newsletter* Chair *(jaking@mit.edu).*

The Challenge Facing Higher Education
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they have no idea what is worth doing." "They can make anything but all they can say is 'awesome.' Can you help us understand this? What should we do?" I am still struggling with these questions. I think many of us are. This is the real immediate challenge, as important as the cost of higher education, political turmoil, climate change.

I begin by looking backwards. Across the last 70 years, beginning with the 1949 Lewis Report and culminating with the recent Task Force on the Future MIT Education, the faculty has periodically taken stock of its educational commitments, each report restating MIT's vision for higher education. Reading through these reports reveals an interesting transformation: post-World War II worries about the capacity of an engineering school to produce socially responsible citizens have evolved into an institutional ambition to spread globally capacities for innovation. The Institute's objective in 1949 was stated simply: to educate "the professional man who is an outstanding citizen." Sixty-five years later, the 2014 Report on the Future of MIT Education envisions the Institute as an "ecosystem for ongoing research, learning, and innovation."

What happened to our goal of responsible citizenship and civic responsibility? Does it comfortably go unstated in our broader vision of an innovation ecosystem? Might this be a moment for conversation about our shared commitments and responsibilities? Educational institutions have historically been committed to imparting existing knowledge to new generations of undergraduate college students, while nurturing their appetite to make new knowledge. What happens when the mission changes: abandoning and breaking free from existing knowledge to create new ideas, new things? This may not be a seamless fit. Might we risk, inadvertently, devaluing the making and accumulation of knowledge? How does innovation and ethical responsibility fit together? Innovation, like efficiency, lacks a politics unless we give it one. Toward what ends are we working and teaching?

Certainly, any flourishing organization will, and should, change over three-quarters of a century. Of course, change is neither easy nor unidirectional, and the tensions between preserving what is excellent and ambitions to make improvements are persistent. Yet, at particular historical moments the push for change can be noticeably stronger than usual. It is often unclear whether change agents are responding to needs or are themselves the impetus driving the conditions for change. In the last two academic years alone, the faculty has approved six new undergraduate majors, nine minors, four graduate degrees, as well as eight additional modifications; committees are currently exploring new degrees and the pattern of major enrollments. The currently voiced discontent with MIT's undergraduate curriculum can be interpreted as the latest permutation in a history of continuing reevaluation and renewal or, perhaps, an expression of something else more contemporary: the widespread embrace of disruptive innovation.

In 1971, also a period of political upheaval, and also a time when the curriculum was congested by the perceived expansion of technological knowledge, Benson Snyder, at the time MIT psychiatrist-in-chief and Dean of Institute Relations, offered a trenchant analysis of higher education. He argued that the experience of undergraduates was marked by a discrepancy between explicit demands (such as completing assignments) and unstated academic and social norms. Referring to the tacit norms as the "hidden curriculum," Snyder detected a conflict between students and instructors rooted in instructors' assumptions and values, students' expectations (which are inchoate and in a process of development), and the historical moment and social context in which the parties found themselves (rapidly changing cultural norms). Snyder interpreted the conflict over the hidden curriculum as a source of students' anxiety, depression, and alienation. Education was reframed, for and by students, as a competition, a type of game to master rather than a quest for knowledge or a process of moral development. The problem Benson identified is not only the expanding formal curriculum but also the various messages embedded in the way we organize and justify the curriculum.

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How much has changed over these decades? What is today's hidden curriculum? Certainly the call for teaching about, and producing, innovation is clear. However, Benson was concerned about something less explicit: "the *kinds of dissonance* that are created by the distance between" the formal expectations and the informal responses and messages. "The hidden curriculum imparts to the students what particular performance is wanted from them," Benson wrote. What does innovation communicate? What does it demand of our students? Entrepreneurship or truth? While not mutually exclusive, are we asking them to pursue profit and market-making in lieu of knowledge and responsible citizenship? What do the students' hear in the call for innovation?

Innovation, likened or not to disruption, is not simply an injunction or aspiration; as the Harvard historian Jill Lepore writes, it is a theory of social change, an explanation for how the world works. Moreover, as a model of change, it supplants alternative accounts. "The eighteenth century embraced the idea of progress; the nineteenth century had evolution; the twentieth century had growth and then innovation. Our era has [added] disruption, which, despite its futurism, is atavistic. It's a theory of history founded on a profound anxiety about financial collapse, an apocalyptic fear of global devastation, and shaky evidence," Lepore writes [Jill Lepore, "The Disruption Machine: What the Gospel of Innovation Gets Wrong," *New Yorker*, June 23, 2014, ***www.newyorker.com/magazine/2014/06/23/the-disruption-machine***]. She documents the shabby empirical evidence for this theory of change as disruption. But, in this age of hyper communication, instant analysis, and media driven frenzy, we rarely take the unhurried time to critically engage with the rapidly circulating narratives, such as those whose protagonist is innovation. "Even people who cherish the idea of progress," Lepore claims, and who "point to improvements like the eradication of contagious diseases and the education of girls, have been hard-pressed to hold on to it while reckoning with two World Wars, the Holocaust and Hiroshima, genocide and global warming. Replacing 'progress' with 'innovation' skirts the question of whether a novelty is an improvement: the world may not be getting better and better but our devices are getting newer and newer."

Disruptive innovation is an idea bred at Harvard Business School. Like many management models, it is expertly marketed and thus has become the moment's gospel. Recipes for management efficiency, even when on a smaller scale, embed theories of change often without sufficient scrutiny of their social impact. I note, however, the stated mission of the MIT Sloan School: to develop principled innovative leaders who improve the world.

How can we distinguish the well-marketed hype of disruptive innovation from a predictive theory of social change with which we can engage as teachers and scholars? At MIT there are several fine classes that do exactly that: systematically explore the major contending models for analyzing and explaining historical (temporal) and social (distributional and structural) change. Such explorations reveal how the major social movements that have characterized modern history – beginning with the early peasant revolts, the liberal revolutions, the socialist movements of nineteenth and twentieth centuries, the post-colonial liberations as well as the environmental movement of more contemporary times – have each represented transformations in understandings of social change, specifically accounts of when and how human agency and power shape the world.

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Lepore reminds us that,

". . . innovation and disruption are ideas that originated in the arena of business but which have since been applied to arenas whose values and goals are remote from the values and goals of business. Public schools, colleges and universities, churches, museums, and many hospitals, all of which have been subjected to disruptive innovation, have revenues and expenses and infrastructures, but they aren't industries in the same way that manufacturers of hard-disk drives or truck engines or dry-goods are industries. Journalism isn't an industry in that sense, either.

"Doctors have obligations to their patients, teachers to their students, pastors to their congregations, curators to the public, and journalists to their readers – obligations that lie outside the realm of earnings, and are fundamentally different from the obligations that a business executive has to employees, partners, and investors. . . . Charging for admission, membership, subscriptions and, for some, earning profits are similarities these institutions have with businesses. Still, that doesn't make them industries, which turn things into commodities and sell them for gain."

Accounting for the differences among these institutions in the narratives about disruptive innovation is critical if we are to understand the complexity of change. When we talk about education as innovation, are we burying talk of responsibility? Or, possibly, is this meme creating new spaces in which to be more self-conscious, less hidden or opaque about our responsibilities?

What is a college education for? Certainly as a university in which 75% of students graduate – even if all do not work – as engineers, we are providing job training. But, how are we educating these engineers? When I rode the New York City subways as a teenager, I was always dismayed by the abundant, often government-sponsored advertisements that said, "Get an education, get a job." It hadn't occurred to me that one got an education

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in order to get a job. Perhaps my naiveté was a residue of pre-feminist consciousness, but I think not; I always knew I had to and would go to work. But I thought one got an education to learn how to think, to discover what had happened in the past, and why the world is the way it is, to "know stuff" as my teenage vocabulary may have said it. Yes, education could get me a better paying job, but I cannot recall a single class in college or graduate school that actually prepared me to teach – except by mimicking my professors. And this was not always for the better, certainly. Sadly, when I went to graduate school, we were not taught how to do research; again, one had to mimic what our professors did without explicit methodological instruction. Times have surely changed, and for the better in many ways.

In a challenging speech welcoming the freshmen class to the University of Chicago, the sociologist Andrew Abbott explained to the students that few, with the exception of scientists and engineers, will ever work at a job in which their college major is required preparation. Doctors, lawyers, ministers, writers, and business leaders will have studied many different, often seemingly irrelevant and impractical, subjects. The sociological data show that worldly success does not depend on what is studied in college, nor is it predicted by college performance. Being admitted to a selective institution by itself puts these students in a life-long trajectory at the upper tiers of American society. The selection by the college and the choices made following college are predictive of worldly success.

However, what college education offers, even for scientists and engineers, is the chance to learn how to make distinctions, what Abbott calls mental gymnastics: to learn to see the world from multiple perspectives, with complex dimensions, often to slow down as you encounter phenomena and take a closer look. "We should not want education now in order to get something later," he writes. Education is an end in itself simply because it makes life better. [Andrew Abbott, "The Aims of Education Address," *The University of Chicago Record*, November 21, 2002, 4-8.] The educated life is better because each event becomes a more complicated experience, a puzzle for unraveling and understanding, apprehension and, yes, sensual enjoyment. When jobs call for a college education, the employer seeks a workforce that can do the mental gymnastics that balance uncertainty with action, multiple demands with opposing interests. A recent study by Wellesley College sociologists Lee Cuba and Joseph Swingle and colleagues describes a college education as exactly that: learning to make choices, "a liminal space and place in which students make lots of decisions that serve as practice for the many more they will make as adults." [Lee Cuba, Nancy Jennings, Suzanne Lovett, and Joseph Swingle, *Practice for Life: Making Decisions in College* (Cambridge: Harvard University Press, 2016), 170.]

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I like to think about MIT as a modest institution that has managed over its lifetime to do some extraordinary things. What happens when we see ourselves no longer as a modest yet successful university but as extraordinary, a global innovation leader? We celebrate both *mens et manus*, teaching ways of doing things but also ways of thinking. Is the hidden curriculum the fact that we also teach ways of being and feeling? MIT has always excelled at teaching how to make things; it may be what we are uniquely good at relative to other institutions. Perhaps, however, MIT's true power comes in those moments when it is able also to teach people ways of thinking and feeling that they take into those ways of making and doing.

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A Hole in the Flag

Haynes Miller

THERE IS A FLAGPOLE outside my office window in Lowell Court, from which the flag of the Commonwealth of Massachusetts flutters. I noticed yesterday that the flag is badly torn; there is a large hole in the center.

This struck me as a metaphor for the commonwealth of MIT today; one of its most characteristic and beloved institutions has been torn away.

As an MIT faculty member since 1986, I am deeply troubled by the MIT administration's expressed attitudes and actions culminating in the elimination of Senior House. From beginning to end, these attitudes have contradicted what I have always seen as core values of MIT, values that distinguish this institution and contribute to its greatness.

Valuing diversity means supporting communities with values that differ from your own. The administration seems to have adopted a narrow view of the lifestyles that are welcome at MIT. If you – or your suitemate – take a little longer to graduate than the norm, expect to be ostracized.

If your allegiance to your dorm is too strong, you are part of the problem.

The administration's actions undermine the sincere efforts of those hanging out rainbow "You are welcome here" signs.

The administration cites various statistics (some obtained, it appears, under false pretenses), involving, for example, time to graduation. This is clearly a quantity they would like to minimize, in the aggregate. But at what cost? And what evidence is there that these same individuals would have finished quicker if they had not lived in Senior House?

I imagine that these data looked about the same 10 or 20 years ago. No evidence is presented that Senior House has changed. What was the precipitating factor? What seems to have changed is the attitude of the MIT administration.

A letter to the MIT community from a large group of Senior House students, published on July 26 in *The Tech*, calls for a faculty investigation of the sequence of events leading up to the destruction of this long-standing MIT community. I strongly support this proposal!

Haynes Miller is a Professor in the Department of Mathematics *(hrm@math.mit.edu).*

Teach Talk

How Deeply Are Our Students Learning?

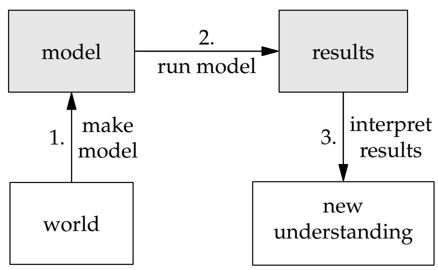
Dennis Freeman
Sanjoy Mahajan
Warren Hoburg
David Darmofal
Woodie Flowers
Gerald Sussman
Sanjay Sarma

WE WRITE ABOUT A long-standing global issue related to students' mastery of fundamental STEM knowledge. Namely, when students are asked questions that test deep understanding, they often guess and merely manipulate symbols without insight – even though they can solve traditional homework and exam questions.

At a time of great change in education, we should solve this problem first in order to place subsequent educational changes on solid ground. We do not blame the students. Rather, it is a problem that we as a faculty have created and have the responsibility, and perhaps the knowledge, to solve. Here are two examples of the phenomenon, which we find in every field of introductory science and engineering that we have taught, including dynamics, computation, calculus, and signals and systems.

1. Students who can manipulate the algebra for complicated statics and dynamics problems often cannot use Newton's laws and free-body diagrams, the bases of dynamics, to model the world.

2. Students who can evaluate integrals with facility often cannot set up the same integrals from a description of the underlying physical process. Students live in the upper world of mathematics, where they competently execute the second step: running the model (see next column). However, they have much more trouble with the surrounding skills: making the model and interpreting its results. For them, mathematics is not a tool for understanding or changing the world.



The problem seems neither limited to our students nor to the United States. We have seen the same phenomenon at other selective institutions, including Olin College and the University of Cambridge. And the research in this area that we will describe ranges from the UK to North America (Berkeley, University of Washington, Harvard). The extended range of the problem might even be welcome, for we can benefit from shared and wide experience. Noted physicist and science educator Carl Wieman, in an NPR interview about his recent book on transforming science education [19], described noticing the same problem 30 years ago: "I was surprised . . . . [T]he [graduate] students coming in [to] my physics research lab – they had done great in all these courses but they didn't seem . . . to know how to do physics." ["The College Lecture? Nobel Laureate Gives it a Failing Grade," KQED Radio, May 25, 2017, online at ***https://ww2.kqed.org/forum/2017/05/24/nobel-laureate-carl-wieman-wants-to-to-end-the-college-lecture/*** at 24:30.]

The physics-education research community has investigated this area [1, 6, 7, 9, 10, 13]. At MIT, the TEAL project in physics [3, 4] showed that the problem also occurred at MIT, and the project developed conceptual questions to improve students' understanding of mechanics and electro-magnetism. In this article, we amplify that conclusion, indicating that the problem of rote symbol manipulation remains deep and more widespread than we as a faculty have thought and that current solutions have been insufficient. We also discuss why the severity of the problem is not widely appreciated, its consequences for our students, and the benefits of solving it.

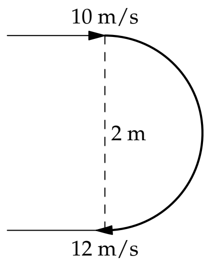
1 Examples

In the first examples below, we focus on dynamics (motion and force), which has the most extensive studies. However, as we then illustrate with examples from programming and circuits, the phenomenon seems discipline agnostic.

1.1 Motion

Fundamental to modern physical science and engineering is motion: its prediction and production. Here we give examples of students' difficulties even describing motion. The first comes from J. W. Warren, who taught physics at Brunel University in London. He asked engineering and science majors first to identify the vectors among speed, velocity, and acceleration. Then he gave them the diagram shown and the following problem [17]:

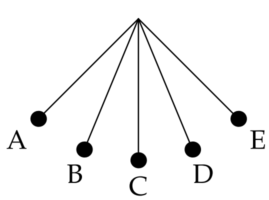
> *A particle moves in the path shown, the speed increasing uniformly with time in the semicircular section, from 10 m/s to 12 m/s. For this section of the path calculate the averages of (a) the velocity (b) the acceleration. (Use $\pi = 22/7$.)*



Warren reported [18, p. 2] that "correct answers to these questions are practically never obtained." We have tried this question with second- and third-year students at Olin and MIT and can confirm Warren's lament. In the Olin course (Mechanical Engineering Dynamics), one student (out of 24) solved part (a) correctly, and another student solved part (b) correctly. In the MIT course (16.07: Aero/Astro Dynamics), one student (out of 35) solved part (b) correctly, and no student solved part (a) correctly.

A second example comes from Reif and Allen at Berkeley and their colleagues at the University of Washington. They asked students to give the acceleration (as a vector) of a pendulum bob at five points as it swings between the extremes at A and E. Their results are sobering [13, p. 19]:

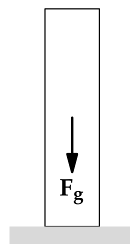
> *Of 124 students who had studied acceleration in the introductory physics course, none could answer this problem correctly; of 22 graduate-student teaching assistants, only 15% could answer it correctly; and of 11 graduate students on their PhD qualifying exam, only 20% could answer it correctly.*



1.2 Force

As important as motion is its cause, force – where students' understanding also falters. A fundamental aspect of force is that it is one side of an *interaction* between two objects. To test students' understanding of this property, Terry and Jones [15] in the UK gave four problems to 16-year-old students after O-level Physics (roughly comparable to AP Physics). Here is one problem.

> *The diagram shows a person standing on the ground and the gravitational force F_g of the earth on the person. What is the Newton's-third-law force that is paired with F_g?*



Only two students out of 39 correctly answered with the gravitational force on the earth. Of the 37 wrong answers, two-thirds were the contact force – indicating students' deep confusion between Newton's second and third laws. We have found similar results: At Olin, in Mechanical Engineering Dynamics, the correct force was named by one out of 24 students.

We have also asked a second-law question of students in 2.003 (Mechanical Engineering Dynamics), in 16.07 (Aero/Astro Dynamics), and in Mechanical Engineering Dynamics at Olin.

> *A small steel marble with mass m is dropped 1 meter onto a steel table, from which it bounces upward and almost perfectly elastically. At the instant during the bounce when the ball's center of mass is stationary, what force does the table exert on the ball? (a) 0 (b) mg (c) 2mg (d) >2mg*

The correct answer, $F > 2mg$, was chosen by only 20 percent of our students. The rest of the answers are mostly divided between mg, which violates Newton's second law, and $2mg$, which, while possible theoretically, does not represent any steel ball bouncing in the real world.

When a problem combines motion and force, students' confusion deepens. Again we turn to Warren [17]. His study was conducted in 1969, when the standard of A-level Physics was very high [2] (much higher than AP Physics). Asked about a car moving at constant speed in a circle with no wind blowing, science and engineering majors (most of whom would have taken A-level Physics) were asked for a diagram showing the resultant force, the friction force exerted by the ground on the car, and labeled arrow(s) for any other force(s) on the car (all in the horizontal plane).

In only 47 out of 148 diagrams was the resultant force the sum of the other forces, of which only 14 showed the correct, radially inward resultant. Only 3 students correctly drew the friction force's direction. And only 13 students gave the other force correctly as air resistance. The most common answer was the centrifugal force (51/148), followed by the "driving or tractive" force (31/148), followed by the centripetal force (27/148). Our results, with mechanical-engineering students taking Dynamics, have been almost identical.

1.3 Programming

Lest we be misinterpreted as claiming that all troubles lie with physics and mechanical engineering, we quote the results of the rainfall problem. In the 1980s, Soloway [14] asked students, at the end of a one-semester course in computer science, to write a program that averages the non-negative values in a list, stopping at the end of list or at the first -999 marker. It is a simple program. Yet, across the country, only about 30 percent of students write a correct algorithm (even allowing syntax errors). We have found similar percentages in 6.01 (Introduction to EECS I) as a pre- and a post-test. Thus, our own teaching did not help.

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Mark Guzdial, a professor of computer science at Georgia Tech, asks ["A Challenge to Computing Education Research: Make Measurable Progress," August 16, 2010, ***https://computinged.wordpress.com/2010/08/16/a-challenge-to-computing-education-research-make-measurable-progress/***]:

> *As computing education researchers, we have both goals, to understand and to improve. After 30 years, why hasn't somebody beaten the Rainfall Problem? Why can't someone teach a course with the explicit goal of their students doing much better on the Rainfall Problem – then publish how they did it?* ***We ought to make measurable progress*** *[original emphasis].*

The rainfall problem parallels the lore about the "FizzBuzz" problem: to write a program that prints the numbers from 1 to 100, one per line, with a multiple of 3 replaced by "Fizz," a multiple of 5 by "Buzz," and a multiple of 3 and 5 by "FizzBuzz." The problem is successful enough at filtering applicants for software-developer positions that it is regularly used in early-stage interviews. We have not tried the problem, but it further indicates the pervasiveness of, and the need to ferret out, fundamental conceptual misunderstandings.

1.4 Manipulation without understanding

The next group of examples illustrates that students can perform mathematical operations that they do not necessarily understand. As one manifestation, they can evaluate mathematical expressions that they cannot generate as a model. In this area, we do not know of a body of research but draw on our experiences.

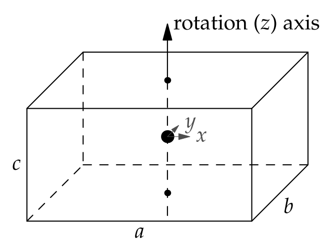
Many areas of engineering, such as signals and systems and controls, use the idea of convolution. It typically leads to integrals of the form

$$\int f(\tau)g(t-\tau)\,d\tau.$$

Given two reasonable functions f and g, our students can usually evaluate these convolution integrals. However, from a description of a physical process that produced the convolution (for example, a signal going through a filter), they cannot *set up* the same integral.

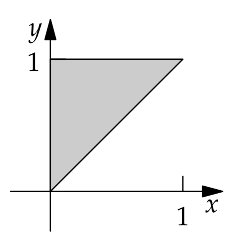
Similarly, they can evaluate integrals to calculate complicated moments of inertia (say, for a solid sphere). But, for much simpler moments, they often cannot even set up the integral.

As an example, on a recent Dynamics exam, students were asked to supply the missing integrand and limits to compute the moment of inertia of a uniform $a \times b \times c$ rectangular prism rotating about the z axis through the prism's center.



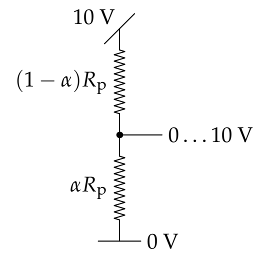
Almost no student gave the correct integrand, which is just x^2+y^2. The expressions offered instead, such as $x^2+y^2+z^2$, indicate that, for the student, moment of inertia has little physical meaning. As teachers, we must do better!

A similar example of students' difficulty making models is in comparing two medical treatments using Bayesian statistics. To compute the probability that one treatment is better than the other, one integrates a joint probability density over the shaded region, where $y>x$ and $x,y<1$.



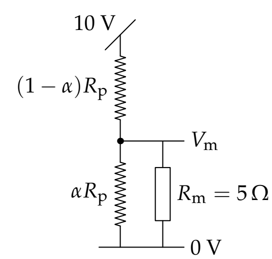
In our experience, few students can determine the limits on the double integral – although, given the limits (the model), they readily evaluate the integral.

A related manifestation of the same problem is that students can make mathematical models that they cannot use. An example comes from the circuits unit in 6.01. The students had, in small groups, built working 0-to-10-volt outputs controlled using a variable resistor with total resistance R_p=5000 ohms.



Students had also powered a LEGO motor with an official 10-volt supply, finding that the motor turned on even at 0.3 volts. And, unpowered, it had a resistance of 5 ohms.

Now they connected the motor to their own 0-to-10-volt output. Yet the motor would not turn on, no matter how they turned the dial on the variable resistor.



Their problem was to explain what went wrong. Almost without exception, they applied the parallel-resistance and voltage-divider formulas several times and got this monstrous expression for the motor voltage:

$$V_m = \frac{\dfrac{\alpha R_p R_m}{\alpha R_p + R_m}}{(1-\alpha)R_p + \dfrac{\alpha R_p R_m}{\alpha R_p + R_m}}.$$

This result was too complicated to offer any understanding of why the motor would not turn on, so students simply plotted the output voltage using a symbolic-mathematics package or service (such as Wolfram Alpha). As Victor

Weisskopf, formerly Chair of the Physics Department, often said (quoted by Sherry Turkle [16]): "When you show me that result, the computer understands the answer, but I don't think you understand the answer."

No circuit designer would or should reason as our students did. Rather, she would apply the meaning of the parallel-resistance formula – that currents prefer low-resistance paths – and see that almost all the current flows through the motor rather than the bottom resistance αR_p. Then most of the 10 volts appears across the top resistance, which is much larger than the motor's few ohms, leaving too little voltage across the motor to turn it on. But this kind of reasoning was not conveyed successfully in our instruction.

2 Why haven't we seen this phenomenon as a problem?

A natural question is why haven't we as a faculty pursued rote symbol manipulation as an existential problem? And why are its depth and implications not more widely appreciated? Here are three possible reasons.

First, the deep misunderstandings are in fundamental and seemingly basic material. So we easily assume that students have mastered it and its real-world connections, and do not probe more deeply. In the modeling process (p. 10), we emphasize the second step, in the math world, implicitly assuming students' mastery of the first and third steps, making and interpreting the model.

Second, homework problems, which can be longer and probe more deeply than problems on a short in-class exam, are often solved in groups. Thus, we do not measure how much each student in the group understands, or know whether one student has understood the ideas and simply told the rest.

Third, we may fear to know – and rightly so. Grasping the depth of the problem would almost compel us to correct it. But how can we, without transforming our pedagogy and every course, from the GIRs to the most advanced? Individual solutions are too hard. Collectively, however, we might solve this problem, which is the reason for this article.

As another natural question, haven't researchers in STEM education also identified these problems and shown their solution? We do not believe so. The severity of the problem is hard to grasp, even for the learning-research communities. Thus, standard solutions, such as "active learning" and "student engagement," do not reach the roots of the problem and are useful more as pointers to the direction to work.

As an example of the depth of engagement that we do seek, here is how one can help students understand, in their gut, the huge forces on the steel marble bouncing off a steel table (p. 11). Take a small rock and rest it on a student volunteer's hand, which rests on a table. "Does it hurt?" "No? Good, so the force *mg* on your hand is not too much." Now raise the rock to about 1 meter and count down to dropping it. As the count nears zero and the student instinctively yanks his or her hand away, play shocked: "But you told me that during the bounce the force is also *mg*, and *mg* didn't hurt. Why are you moving your hand now?" For the many students who now say, "Oh, the force is 2*mg*," rest two rocks on their hand, to show that 2*mg* also does not hurt, and threaten to drop the single rock.

In this kind of engagement, which taps our brains' narrative, visual, and tactile co-processing, we help students bring forth the correct part of their internal gut model: that the force from the rock must be painfully huge, far larger than *mg* and 2*mg* (it's actually a few thousand *mg*). Then we can help them to express that gut understanding using force and acceleration and thereby to give meaning to the fundamentals of dynamics.

3 Consequences

But there is a preliminary question. If our students, among the most highly selected in the world, have such difficulties even when taught by world experts, how much of a problem is rote symbol manipulation? For the following reasons, we think that it is a large problem.

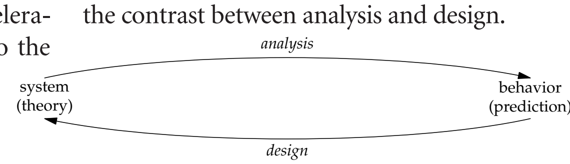
First, rote symbol manipulation provides only a shaky foundation of knowledge. Knowledge built on this foundation will be still shakier. What should form a solid foundation for downstream courses becomes a sandcastle base.

Second, rote symbol manipulation makes teaching a downstream course difficult. After grasping this problem, a single instructor is in a dilemma: "Should I return to and rework the upstream knowledge (often from high school) to rebuild a rock-solid foundation, and risk not building the next required floor? Or should I just build the next floor and hope that it stays upright, although it stands on sand?"

Third, shaky learning is ephemeral, making students study longer and sleep less – a recipe for stress. Shaky learning leads to less transfer and less interest and even to burnout, because the limited learning does not compensate for the large stress.

Fourth, when students lack deep understanding, they are forced to ignore their intuition because it is wrong so often. The divorce between intuitive and symbolic models of the world is memorably described by Eric Mazur at Harvard. He had given his students the Force Concept Inventory [7], a diagnostic test of students' reasoning about force and motion. One student asked him [9, p. 4], "Professor Mazur, how should I answer these questions? According to what you taught us, or by the way I *think* about these things?"

The consequence for engineers and scientists is, in Middlebrook's term [11], "falling off a cliff." Its origin is shown in the contrast between analysis and design.



Much of what we teach in our technical courses is how to go from a system to its behavior or, in science, from a theory to its predictions. This teaching follows the

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analysis arrow. Yet, as practicing engineers or scientists, our onetime students have to solve the opposite problem. Given a desired behavior, they must find the system. Or, given data, they must find an explanatory model (a theory). This task follows the design arrow.

But when they merely manipulate symbols, their design process degenerates to the following. First, guess a possible system. Second, predict its behavior using a simulation system. Third, compare the predicted and desired behaviors. Until they match, try again by guessing another system.

Any real system has many tunable parameters (such as component values, forces, or material properties). So "knob-twiddling" [12] through the many-dimensional parameter space is lengthy and unreliable. A common workaround is to tweak a pre-existing design. But this method will not find novel solutions and radical improvements.

If we do not want our students to become well-paid knob twiddlers, they should understand analysis deeply, learning what Middlebrook described as "invertible methods of analysis" [11, 12]. An invertible method produces its answer – a system behavior – in an insightful form. We may get the time constant of a resistor–capacitor circuit as $\tau = (R_1 \parallel R_2 \parallel R_3)C_2$ rather than as the mathematically equivalent

$$\tau = \frac{R_1R_2R_3C_2}{R_1R_2 + R_2R_3 + R_1R_3}.$$

Feynman [5, p. 53] emphasized the difference between mathematical and psychological equivalence: "[P]sychologically [the two forms] are different because they are completely unequivalent when you are trying to guess new laws" – or design a new system. Indeed, only the invertible form shows the engineer what parameters of the system to change in order to move the predicted toward the desired behavior. Rather than simply trying another guess, the engineer explores the parameter space intelligently and needs less luck to find radically new designs and improvements. This approach to analysis joins it tightly to design. Rigorous and invertible methods of analysis are a foundation for principled, creative design and so for engineering and scientific leadership.

Final thoughts

The problem of rote symbol manipulation, although identified decades ago, is not solved. Even on the limited evidence offered here, the problem is difficult. Any solution would incorporate many ideas and insights. But is the problem even solvable? We do not know. However, we, as a faculty here and with our colleagues elsewhere, must try to solve it as we answer several essential questions. In particular, what is deep learning and how can we foster it? How should we change not only how we teach (the emphasis of much education research) but rather what we teach and how we organize our disciplines' ideas and ways of thinking? On the importance of progress on these questions, Jaynes [8] wrote that

> *the goal [of teaching] should be, not to implant in the students' mind every fact that the teacher knows now; but rather to implant a* ***way of thinking*** *that enables the student, in the future, to learn in one year what the teacher learned in two years. Only in that way can we continue to advance from one generation to the next. [original emphasis]*

To that end, we welcome your questions, comments, and suggestions.

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Thank You From the MIT Alumni Association

Joel L. McGonegal

THE MISSION OF THE MIT Alumni Association is to connect MIT's 137,000 living alumni with one another and with the Institute, a commitment we take seriously for alumni of all ages, academic degrees, and destinations after leaving Cambridge. We simply cannot fulfill this mission each year without the support and collaboration of countless campus partners.

While our partnerships may be countless, we *can* count the MIT faculty and researchers who volunteer their time each year to share news of their research and teaching with alumni for whom an MIT education is a lifelong endeavor.

In our fiscal year ending June 30, 2017, we counted 99 MIT faculty who spoke at alumni gatherings, from our largest events at Tech Reunions, MIT Family Weekend, and the Alumni Leadership Conference, to talks over dinner or post-conference gatherings with alumni clubs and groups near and far. (See the list below.) Beyond speakers, we were also delighted to see over 250 MIT faculty among the attendees at our events this year.

To those in these sets, we say both thank you – and let's do even more together.

Like our colleagues in Resource Development, Alumni Association staff focus on understanding and communicating MIT's advances in research and education to alumni and friends. This focus is made sharper in the midst of the Campaign for a Better World, one with ambitious donor participation and event engagement goals.

In the alumni education office, we have doubled our efforts to maximize the connections among faculty, researchers, and alumni. We track all faculty appearances worldwide that we know of on one central calendar, and we alert alumni when faculty are giving public talks or speaking at conferences in their areas. We stay current on research and liaise with organizers of major research conferences. We have doubled production of Faculty Forum Online Webcasts in which alumni can interact virtually with faculty. And we have piloted new kinds of events, both virtual and real-time, for alumni to connect with the research and people who make MIT great.

In this past year, over half of the 22,000 alumni who attended an MIT alumni event did so to engage directly with researchers. If we do our jobs right, this percentage will climb in the years ahead. So we are almost always willing to partner and collaborate with departments, labs, centers, and individual faculty, whether given a week's notice or a year's, if it means amplifying their message to our alumni.

Each summer the MIT Alumni Association offers faculty and research staff two ways to connect with us. Our annual Toast to Faculty event in August brings staff and faculty together to reflect on the year past and consider possibilities in the year ahead. Those who could not attend the August event can collaborate with us this year by completing a simple survey at ***surveymonkey.com/r/mitaa***.

Thank you to the following individuals who volunteered to speak at alumni events in the last year. Are we missing your name? Please let us know.

Joel L. McGonegal is Director, Alumni Education *(jmcg@mit.edu)*.

Eric Alm
Daniel Anderson
Robert Armstrong
William Aulet
Arnold Barnett
Martin K. Bazant
Angela Belcher
Adam Berinsky
Dimitris Bertsimas
Sangeeta Bhatia
Richard Binzel
Emilio Bizzi
Amanda Bosh
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Woodie Flowers
John Gabrieli
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Linda Griffith
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Nominate a Colleague as a MacVicar Faculty Fellow

PROVOST MARTIN SCHMIDT is calling for nominations of faculty as 2018 MacVicar Faculty Fellows.

The MacVicar Faculty Fellows Program recognizes MIT faculty who have made exemplary and sustained contributions to the teaching and education of undergraduates at the Institute. Together, the Fellows form a small academy of scholars committed to exceptional instruction and innovation in education.

MacVicar Faculty Fellows are selected through a competitive nomination process, appointed for 10-year terms, and receive $10,000 per year of discretionary funds for educational activities, research, travel, and other scholarly expenses.

The MacVicar Program honors the life and contributions of the late Margaret MacVicar, Professor of Physical Science and Dean for Undergraduate Education.

Nominations should include:

- a primary nomination letter detailing the contributions of the nominee to undergraduate education,
- three-to-six supporting letters from faculty colleagues, including one from his or her department head if the primary letter is not from the department head,
- three-to-six supporting letters from present or former undergraduate students, with specific comments about the nominee's undergraduate teaching,
- the nominee's curriculum vitae,
- a list of undergraduate subjects, including the number of students taught, and
- a summary of available student evaluation results for the nominee.

For more information, visit ***web.mit.edu/macvicar*** or contact the Registrar's Office, Curriculum and Faculty Support at x3-6776 or *macvicarprogram@mit.edu*.

Nominations are due by Friday, November 17, 2017.

Request for Proposals for Innovative Curricular Projects

The Alex and Brit d'Arbeloff Fund for Excellence in Education

THE VICE CHANCELLOR IS currently soliciting proposals for the d'Arbeloff Fund for Excellence in Education for MIT faculty-led projects that strengthen undergraduate education and enrich the experiences of our undergraduates. Proposals can be focused at any level of undergraduate education; priority will be given to projects that:

- Improve the first-year academic experience, including the General Institute Requirements (GIRs)
- Explore ways of including algorithmic reasoning and computational thinking in the curriculum (along the lines described in the report of the Study Group on Algorithmic Reasoning and Computational Thinking)
- Develop student motivation, confidence, and self-efficacy by providing opportunities to demonstrate educational accomplishments in authentic contexts
- Support students in exploring and choosing majors
- Enhance undergraduate advising – including professional and career development discussions – between faculty and students

Proposals that make use of innovative, active, and/or inclusive pedagogies to improve student learning and the student experience are encouraged, as are projects that transcend specific departmental curricula, and/or make use of online technology.

If you have participated in the d'Arbeloff Fund process before, you will notice that there has been a change; there will now be one opportunity to submit a detailed proposal to the d'Arbeloff Fund Selection Committee. The Selection Committee places a high value on assessment of educational innovations and encourages sharing of good practices and results. The Teaching and Learning Laboratory (TLL) has resources to help you in developing an assessment plan for your proposals. All award recipients are expected to attend an assessment workshop offered by the Teaching and Learning Laboratory in November or to otherwise discuss their project with TLL. A final report on the project at the end of the funding period is also required.

For guidelines and more information, visit ***web.mit.edu/darbeloff*** or contact the Registrar's Office, Curriculum and Faculty Support at x3-6776 or *darbeloff-fund@mit.edu*.

Proposals are due by Friday, September 29, 2017.

Teaching this fall? You should know . . .

. . . the Faculty regulates examinations and assignments for all subjects.

View the complete regulations at ***https://facultygovernance.mit.edu/rules-and-regulations#term-regulations-and-examination-policies.*** Select requirements are provided below for reference. Contact Faculty Chair Susan Silbey at ***exam-termregs@mit.edu*** with questions or requests for exceptions.

No required classes, examinations, oral presentations, exercises, or assignments of any kind may be scheduled after the last regularly scheduled class in a subject – whether full-term or half-term – except for final examinations scheduled through the Schedules Office. The last class day for all subjects is Wednesday, December 13, 2017.

Undergraduate Subjects

In both **full-term subjects** and **half-term subjects**, faculty must provide by the end of the **first week** of classes:

- a clear and complete description of the required work, including the number and kinds of assignments
- the approximate schedule of tests and due dates for major projects
- an indication of whether or not there will be a final examination, and
- the grading criteria and procedures to be used

In **full-term subjects**, by the end of the **third week**, faculty must provide a precise schedule of tests and major assignments.

In **half-term subjects**, this information must be provided by the end of the **second week**.

Regularly scheduled academic activity between 7 pm and 10 pm always takes precedence over evening review sessions or exams/quizzes. Hence:

Evening review sessions should be optional, and should be described as such. It is good practice to announce them explicitly as being for those students who do not have classes on the evening in question; some instructors schedule two review sessions to provide alternate times.

In the case of an evening exam/quiz, you must make available an alternate time for any students with such a conflict. (Note: Evening exams/quizzes may be scheduled **only** on a Tuesday, Wednesday, or Thursday.)

When **held outside scheduled class times, tests must:**

- not exceed two hours in length
- begin no earlier than 7:30 p.m. when held in the evening, and
- be scheduled through the Schedules Office

In addition, during the same calendar week, either a regularly scheduled class session must be cancelled *or* no assignment will be due.

In all **full-term** and **H2 half-term** undergraduate subjects, there may be no tests after Friday, December 8, 2017. Unit tests may be scheduled during the final examination period. For each undergraduate subject with a final examination, no other test may be given and no assignment may fall due after Friday, December 8, 2017. For each subject without a final examination, at most one assignment may fall due between December 8 and the end of the last regularly scheduled class in the subject.

For **H1 half-term** undergraduate subjects, the final week of the class is considered to be the Half-Term Final Examination Period. There may be at most one assignment due or one exam held during this final week of the class.

Graduate Subjects

In **full-term subjects**, faculty must provide by the end of the **third** week:

- a clear and complete description of the required work, including the number and kinds of assignments
- the schedule of tests and due dates for major projects
- an indication of whether or not there will be a final examination, and
- the grading criteria and procedures to be used

In **half-term subjects**, faculty must provide this information by the end of the **second** week.

For each **full-term** and **H2 half-term** graduate subject with a final examination, no other test may be given and no assignment, term paper, or oral presentation may fall due after Friday, December 8, 2017. For each **full-term** and **H2 half-term** graduate subject without a final examination, no more than one of the following may be given or fall due between December 8 and the end of the last regularly scheduled class in the subject: in-class test, assignment, term paper, or oral presentation.

For all **H1 half-term** graduate subjects, **with** or **without** a final examination, the final week of the class is considered to be the Half-Term Final Examination Period. There may be at most one exam held or one assignment, term paper, or oral presentation due during this final week of the class.

Student Holidays

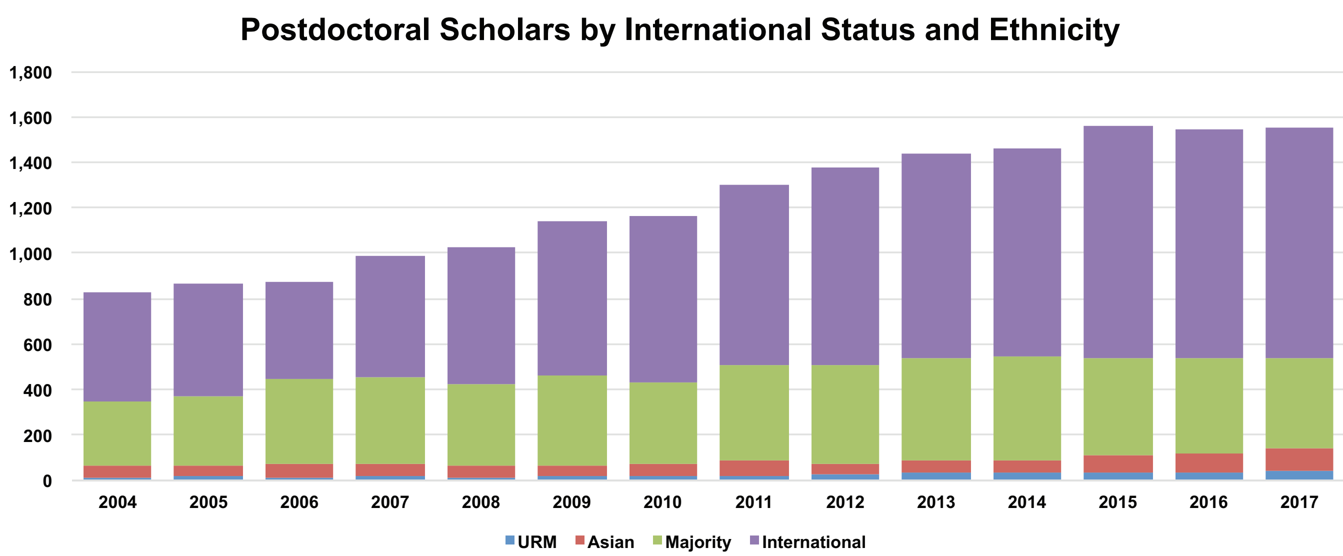
There are no classes on the following dates: Friday, September 29 (Student Holiday and Fall Career Fair); Monday, October 9 (Columbus Day), and Tuesday, October 10; Friday, November 10 (Veterans Day); Thursday, November 23 (Thanksgiving) and Friday, November 24.

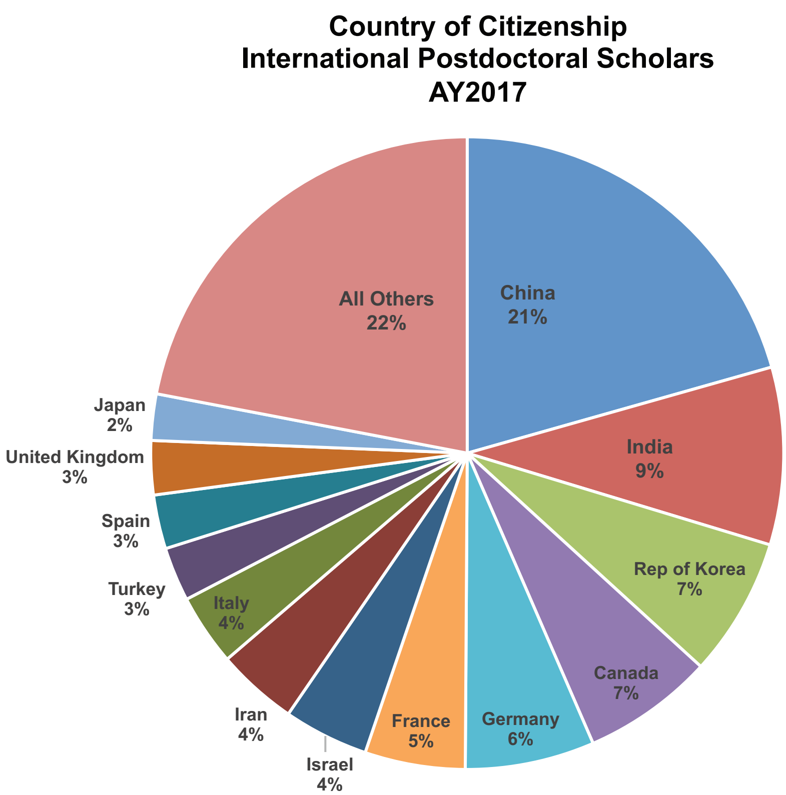
Collaboration Policy and Expectations for Academic Conduct

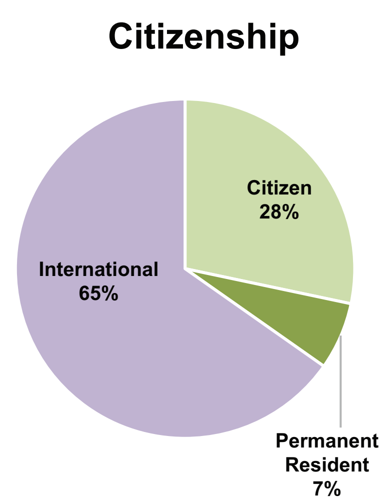
Due to varying faculty attitudes towards collaboration and diverse cultural values and priorities regarding academic honesty, students are often confused about expectations regarding permissible academic conduct. It is important to clarify, in writing, expectations regarding collaboration and academic conduct at the beginning of each semester. This could include a reference to the *MIT Academic Integrity Handbook* *(**integrity.mit.edu**).*

M.I.T. Numbers

Postdoctoral Scholars







Source: Office of the Provost/Institutional Research