Institute-wide Task Force on the Future of MIT Education

Preliminary Report

November 21, 2013

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INTRODUCTION

In his charge to the Institute-wide Task Force on the Future of MIT Education, MIT President L. Rafael Reif asked “that this Task Force *be bold* in experimenting with ideas that would both enhance the education of our own students on our own campus and that would allow us to offer some version of our educational experience to learners around the world.” This preliminary report of the Task Force on the Future of MIT Education is intended to communicate evolving themes and to describe opportunities to strengthen the Institute’s global leadership in education. It represents the exploration of a wide range of ideas that have emerged over the past six months. The possibilities for experimentation contained in this report reflect the collaborative efforts of faculty, students, and staff who brought their experience and knowledge to this work. With the guidance of advisory groups and input from the broader MIT community through the Idea Bank and group discussions, this work also reflects MIT’s unwavering commitment to excellence, innovation, and service to the world.

Implementing an ecosystem to enable ongoing learning about education, and launching the experiments that will make it possible to refine and realize the vision for the future of education at MIT, will surely continue well into the future. As we begin to consider possibilities for reinventing education at MIT, we do so recognizing the global appetite for learning, and the role technological advances can have in reaching new audiences. These advances in educational technology combined with a growing public dialogue about the cost of higher education in America have brought us to this moment. Tremendous opportunities lie before us, and we need to thoughtfully and collectively evaluate the many possibilities for experimentation, and determine together how to build on MIT’s legacy of educational innovation.

The History of Educational Innovation at MIT

In founding the Institute in 1861, MIT’s first president, William Barton Rogers, launched a grand and daring experiment in teaching: the kind of hands-on, science-based, problem-focused engineering education that remains an MIT signature even now. Today, it is hard to imagine teaching engineering any other way. But at the time—when rote memorization was the norm in college classrooms across America—Rogers’s *mens et manus* (“mind and hand”) approach to teaching was a bold departure. This account from one of his early students, Robert Richards, MIT Class of 1868 and later head of the Mining and Metallurgy Department, makes the contrast clear:

> The method of teaching was completely new to all of us. We found ourselves bidding goodbye to the old learn-by-heart method, and beginning the study of observing the facts and laws of nature. We learned from experiment and experience what might be expected to happen if a given set of forces started to act. In short, our feet were set at last in the way of real knowledge. We learned, perhaps falteringly at the outset, the four steps that mark the only route to true science: how to observe, how to record, how to collate, and how to conclude. The effect on the classes was totally different from anything that I had seen in any school before.[1]

1. Richards, Robert H. *Robert Hallowell Richards, His Mark*. Boston: Little, Brown; 1936.

Rogers began this great experiment in response to an urgent need. Although the nation was experiencing rapid industrial growth, its citizens were almost completely unschooled in the scientific and engineering principles that would give them the power to improve processes and invent new solutions. His insistence on hands-on, scientifically grounded education helped accelerate America's industrial revolution, spawned countless innovations and industrial pioneers, and profoundly influenced the modern, laboratory-based approach to scientific education.

Several generations later, in the 1930s, under the leadership of MIT's ninth president, Karl Compton, MIT led a new charge to rethink engineering education by elevating fundamental science and fostering cross-disciplinary problem-solving. This willingness to embrace new ways of thinking and to combine theory with hands-on learning set the stage for all that was to come. After World War II, enabled by a new federal commitment to funding peacetime scientific research, MIT reinvented itself as a modern research university.

In 1959, MIT's eleventh president, Julius Stratton, wrote that the Institute faced a "numbers problem" as more students than ever sought out an MIT education, a trend that was putting unprecedented pressure on faculty and instructional staff. He wrote:

> We shall be faced in the future at MIT, and at comparable institutions all over the country, with the need to teach difficult, basic subjects to larger groups of students. We may be compelled to break with conventions of the past. Certainly it is time for bold and creative thinking about the methods and processes of instruction as well as about the substance. We should re-examine with an open mind the relative merits of the lecture, recitation, tutorial, and seminar methods, and we should be progressive in the use of every modern technique for the effective presentation of subject matter in classroom and laboratory.[2]

President Stratton understood MIT's value to the world and foresaw the need for creatively reexamining traditional methods of education in order to reach a larger audience of learners. In his 1959 report, President Stratton noted that the Department of Mathematics was experimenting with offering lectures through closed-circuit television, with students using microphones to ask questions. President Stratton could not have imagined the transformative power of the Internet in instantaneously connecting learners around the globe, but the principles he articulated over a half-century ago helped to define MIT as an early adopter of new technologies in enhancing the educational experience. The need for "bold and creative thinking" is what drives the Task Force now in imagining a new model of higher education for future generations of learners.

The History of Online Education at MIT

The use of online education and digital tools at MIT began in 1983 under the leadership of MIT's fourteenth president, Paul Gray, and with the launch of Project Athena, a digital experiment in providing widely distributed, client-server computing for education on campus, with a focus on undergraduate education. Athena made a variety of online educational resources available on the campus network, including:

2. Stratton, Julius. Massachusetts Institute of Technology Bulletin, President's Report, Vol. 95, No. 2, 1959: 13.

1. Networked Educational Online System (NEOS), also known as Turn-In/Pick-Up, which allows students to turn in, and their instructors to grade and return, assignments electronically;
2. Online Teaching Assistant (OLTA), a system by which students consult electronically with their TAs while logged in and working on an assignment;
3. Online With Librarians (OWL), a system by which patrons may consult electronically with reference librarians from the various MIT Libraries;
4. Tools for programmers;
5. Access to a suite of other electronic library services, databases and reference tools; and
6. Assistance through Athena Online Consulting (OLC), a service that provides support for faculty, students, and other users of the system in the form of training, documentation, consulting, and project assistance from faculty liaisons.

Of particular relevance to the evolution of massive online open courses (MOOCs) are two independent advances: the development of automatic tutors and the launch of OpenCourseWare (OCW).

MIT has a long history of trying to enhance active engagement in teaching, from the Experimental Study Group (ESG) in 1968,[3] to the development of the Technology Enhanced Active Lecture (TEAL) classroom in 2002.[4] The development of automatic tutoring systems, computer systems that can provide immediate and customized feedback to learners, made it easier for students to grasp material outside of the classroom. This was an important complement to the goal of making in-class experiences more engaging. Many automatic tutors started emerging around the world including several at MIT in the late 1990s and 2000s.[5,6,7] By 2005 it was becoming clear that online learning was a powerful tool in educating students.

The launch of OCW at MIT in 2002 was another important milestone in online learning, and brought into focus the benefits and opportunities of global online access to learning resources.[8,9,10] The mission of OCW is to make all of MIT's undergraduate and graduate courseware available openly to anyone in the world. In addition to course notes, problems and curricula, OCW also published videos of select lectures including the famous physics lectures by Professor

3. Valley, George E. "My Years in the MIT Experimental Study Group," http://www.mit.edu/~jrising/webres/myyears.pdf.

4. Belcher, John W. "Improving student understanding with TEAL," MIT Faculty Newsletter, Vol. 16, No. 2, 2003: 1–8.

5. Pritchard, David E. "CyberTutor: an effective combination of tutoring, assessment, and educational research," American Physical Society, 34th Meeting of the Division of Atomic, Molecular and Optical Physics, May 20–24, 2003, Boulder, Colorado.

6. Newman, John H., Tomás Lozano-Pérez, and W. Eric Grimson. "Online presentations show academic performance advantages over auditorium lectures," Poster presentation at American Psychological Society Convention, 2005.

7. Jones, Maggie. "Tutors made to measure," *New York Times Magazine*, September 10, 2010.

8. Long, Phillip D. "OpenCourseWare: Simple idea, profound implications," *Syllabus,* Vol. 15, No. 6, 2002: 12–14.

9. Carson, Steve. "The unwalled garden: growth of the OpenCourseWare Consortium, 2001–2008." *Open Learning,* Vol. 24, No. 1, 2009: 23-29.

10. Kumar, Vijay. "From open resources to educational opportunity," *Research in Learning Technology*, Vol. 13, No. 3, 2005: 241–247.

Walter Lewin.[11] Over the last decade, OCW has published more than 2,000 courses, and today receives more than two million users monthly, of which over a million are unique. While the architects of OCW initially expected teachers to be the primary beneficiaries of the system, it was self-learners from around the world who emerged as the main users.

MIT has also been a leader in developing technologies to support design-oriented project-based learning. For example, the ideas and technologies underlying the LEGO® MINDSTORMS™ robotics kits, now used by millions of students around the world, were developed at MIT and first tested in MIT robot-design competitions during Independent Activities Period (IAP) in the 1990s.[12]

In many ways, MOOCs were born from the convergence of many themes described above: free worldwide access, online videos, and online resources such as simulation toolkits and automatic tutors. Another important development was the emergence of the cloud, which made it possible to instantly scale up a class to serve many thousands of students. The final piece of the puzzle was social networking in the form of discussion forums, which enabled online users to interact with and help one another.

Following the work of the Institute-wide Planning Task Force in 2009 Rafael Reif, who was then Provost, charged a study group to evaluate new educational opportunities around e-learning, scalable educational platforms, educational offerings that use online tools, and opportunities to reach a greater number of students. The work of this group, chaired by Professor Dick Yue, led to the launch of *MITx* in December of 2011. It began with aspirations of an open source platform, course content with credentialing mechanisms, and the opportunity to research how people learn. At the same time, the first MOOC courses were being widely publicized with audiences of over 100,000 students.

MITx launched its flagship class, 6.002x, in spring 2012. More than 150,000 students from around the world enrolled in 6.002x, and more than 7,000 finished the class. In May 2012, MIT "spun out" the software development effort of *MITx* and, together with Harvard University, created a new not-for-profit called edX. EdX is the platform—the combination of technologies and services that host courses posted online by MIT, Harvard, and other partners. *MITx* refers to those courses hosted on edX that reflect the MIT curriculum. One might consider *MITx* courseware as the movie, and edX as the theatre in which the movie plays. In addition to developing and promoting the edX software platform to allow global access to high-quality educational material, edX has two important missions: improving residential education, and advancing teaching and learning through research. As of November 2013, edX has 29 university partners that offer over 90 courses, and it has enrolled over 1.5 million students worldwide.

EdX distinguishes itself in two ways. First, edX's partner universities offer classes of a high standard, and many commentators have described edX courses as rigorous. In describing 7.00x, The Secret to Life, taught by Professor Eric Lander, Kevin Carey of the *New America Foundation* wrote, "the experience was a welcome reminder that real education is hard work."[13]

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11. Rimer, Sara. "At 71, professor is a web star," *New York Times*, December 19, 2007.

12. Resnick, Mitchel, Fred Martin, Randy Sargent, and Brian Silverman. "Programmable bricks: toys to think with," *IBM Systems Journal*, Vol. 35, No. 3-4, 1996: 443–452.

13. Carey, Kevin. "MOOCs, robots, and the secret of life," New America Foundation, June 5, 2013. Retrieved from: http://higheredwatch.newamerica.net/blogposts/2013/moocs_robots_and_the_secret_of_life-85293.

Second, edX courses tend to have very rich assessments and simulations. The assessment tools used in 7.00x, for example, range from an online protein-folding simulator to an online genetics lab. The idea is to create an online experience that captures as much of the essence of the on-campus experience as possible. Carey comments that 7.00x is “a very close translation of a real MIT course.”

The edX software has two major components. The first is a hosted system for offering online courses to hundreds of thousands of students worldwide. The second is an authoring system called edX Studio for creating an edX course so that it can be offered on the edX site. In June 2013, edX delivered on its pledge to open source its software. The same, day, Stanford University joined the open source effort and adopted Open edX as an internal platform. In September 2013, edX announced a partnership with Google to create a new site called MOOC.org, based on the edX software, to enable any entity anywhere in the world to upload a course for a global audience. MOOC.org is powered by the edX software platform, and Google also joined the open-source effort.

EdX offers classes in several modes. The standard MOOC format is for self-learner students who simply wish to learn the material for free. A portion of this population also seeks to earn certificates. For such students, edX and other MOOC providers charge a fee. EdX also offers material that has been developed for a MOOC for licensing to other universities, including recent experiments with San José State, Massachusetts Bay Community College and Bunker Hill Community College. This format is often called a small private online course (SPOC). Institutions like MIT also offer executive education (as opposed to standard curricular material meant for students) to working professionals. At some point edX may become a channel for providing such professional courses either to individuals or to those embedded in companies.

Since the software development effort of *MITx* was spun out to create edX, *MITx* has continued to develop online courses and modules on the MIT campus both for global audiences on edX and for students on campus. Today, more than 20 classes have used the edX software to experiment in various ways with the use of online methods on campus, and over 2,000 unique students at MIT have used the edX software in some form. In December 2012, MIT launched the Office of Digital Learning (ODL) as a focal point for digital educational initiatives. It serves as an umbrella organization to unite *MITx*, OCW, the Office of Education Innovation and Technology (OEIT), and Academic Media Production Services (AMPS) into a single organization focused on digital initiatives.

Trends Influencing the Future of Education

The digital revolution can be felt across a number of industries, from publishing to media to retail, with the following trends surfacing across the spectrum:

1. *Massive scale of adoption*: YouTube, for example, claims a viewership of over one billion unique viewers and over six billion hours of video watched every month.
2. *Increased potential and demand for disaggregating or unbundling products*: Newspapers have become disaggregated into individual articles available piecemeal online. These are often curated and aggregated by other online sites such as The Huffington Post

or Drudge Report. Apple unbundled music albums into 99-cent songs, and users re-aggregate individual songs into their own playlists.

3. *Blurring of boundaries*: Traditional boundaries in various media and platforms are becoming less distinct, creating new opportunities and greater potential for collaboration. The availability of online video through YouTube, iTunes, Hulu, and other sources, for example, has blurred the boundaries between traditional television programming, cable, computers, and mobile phones. Telecommuting has the same effect on the division between offices and homes. Online retail has blurred the boundaries between brick-and-mortar stores such as Walmart, electronic commerce sites such as Amazon, and auction sites such as eBay.
4. *Affordability and access*: The public conversation about the affordability of higher education and the impact of cost on access for all of those desiring to go to college is growing. There is also a growing conversation about the value of education that does not immediately result in jobs.

These trends are occurring in a political environment mired in disagreements on fiscal matters, and in the midst of a still-uncertain global economy, causing some to ask: Why does education cost so much? Some see online learning as an opportunity to make education more affordable.

Advances in online education enable learning to take place anywhere at any time, forcing us to question the meaning of the strict physical and temporal boundaries of the campus. No longer must a student be at MIT to take an MIT class. A student could leave campus for a year to start a company, or continue education well after graduating with a master's degree. The typical time period for an academic degree becomes blurred. This blurring of boundaries shifts the focus from institutions to a learning ecosystem. Resources, relationships, and roles may need to be recast.

A learning ecosystem with permeable boundaries presents possibilities for advancing thematic education—directing education toward an understanding of big problems. It supports integrative learning—pursuing learning in more intentional and connected ways, bridging disciplines, integrating research and teaching, connecting community and college, and presenting informal and authentic real-world learning opportunities that may recast the role of the university and formal education in light of an open world.

The Uniqueness of MIT in This Space

The magic of MIT originates in its culture, defined by the values and principles embodied by and at the heart of the society of MIT. Driven by its culture, MIT provides its students with unique experiences and opportunities on campus and beyond. These opportunities span the triad of research, academics, and community and are exemplified by the power of learning-by-doing, innovation in learning, and learning by teaching. The outcomes of an MIT education can be measured in many ways, including research results, patents, employment rates, and income.

MIT graduates contribute to the world in extraordinary ways, but MIT is able to admit only a fraction of the exceptional students who wish to come to campus. Only 8.2% of undergraduates who applied for the class of 2017 were admitted, and undergraduate selectivity has increased dramatically over the past 20 years among all of MIT's peer institutions. Clearly, there is a vast unmet need for access to high-quality education. By combining online curricula with hands-on project work and brief but intensive on-campus experiences, MIT has the opportunity to reach more people, to infuse some of the magic of MIT into online and blended learning environments, and to impact lives and society in ways not previously thought possible. MIT is in a most unique position to contribute in a meaningful way to this dialogue, and the possibilities for experimentation explored in this preliminary report represent only the beginning of this conversation about how to reinvent and transform the educational experience for students at MIT.

Task Force Working Groups

Three working groups—each comprised of faculty, students and staff—have begun to envision how MIT can build on its legacy of innovation and reinvent the residential university of the future. (See Appendix 2 for Task Force membership.)

1. Working Group on MIT Education and Facilities for the Future
2. Working Group on the Future Global Implications of edX and the Opportunities It Creates
3. Working Group on a New Financial Model for Education

FUTURE MODELS FOR MIT EDUCATION

How specifically does the increased potential for unbundling education and blurring boundaries present opportunities to rethink MIT residential education?

The key is that, if approached in the right way, unbundling can permit rebundling in new and interesting ways.

- It is an opportunity to introduce *flexibility* in the curriculum, in student experiential learning opportunities, and in each student's trajectory through an MIT degree. For example, *modularity* in the curriculum can provide increased flexibility for students to customize their degree programs. Modularity combined with online education permits students to spend a semester or a year away from campus, enriching their educational experience through internships or international experiences.
- It is an opportunity to emphasize *connections*. Modules can be connected in different ways to deepen and enrich learning by linking concepts and outcomes that might otherwise remain disconnected. For example, common modules in a topic like fluid mechanics could be offered across multiple departments, providing complementary disciplinary lenses through which to access the concepts. Integrative projects could explicitly draw on concepts from multiple modules, including project experiences that cut across traditional departmental and school boundaries. Eliciting connections is also an opportunity to establish well-defined prerequisite relationships in a more modular approach to the curriculum—with the effect (at a minimum) of informing students of their level of preparation for subsequent topics. Academic modules could also be connected to applications in the outside world—the fluid mechanics module could be coupled with a module on turbines from an aerospace company, for example.

- It is an opportunity to achieve greater *contextualization* and "education for practical reasoning".[14] For example, modularity together with a rebundling of modules might be a path to better integrate MIT curricula in the humanities, arts and social sciences with engineering and science content, thus promoting understanding of the technical world in context. Or class modules could be combined with a service-oriented field experience.

These opportunities are enabled through a combination of digital learning technologies and face-to-face pedagogical strategies. Achieving them will require a commitment to adopting new models of *blended learning*—again emphasizing the flexibility to use different pedagogies in different settings—and an investment in a diverse and flexible range of spaces that cater to different formats of learning. As we transform our pedagogies, it is also an important opportunity to explore new approaches to *assessment*, ranging from instant feedback to viva voce exams and competency-based assessments.

However, it is essential that we not lose sight of our principles and values in any future state. Indeed, in this time of disruption in higher education, MIT should explicitly establish a set of educational principles and values. These principles and values will guide us in establishing specific educational outcomes and a qualitative MIT culture to which we aspire. In this framework, flexibility then brings our students options—options to reduce or extend their time to degree, options to take a year off-campus to undertake research or obtain relevant professional experience in the middle of their studies, options to engage more deeply in service and teaching opportunities, and options to take classes online over the summer and streamline their programs—each with different pathways and different experiences, but each aligned with MIT principles and values.

Shaping the Future MIT Graduate

What are the desired attributes for the MIT graduates of the future? As we think about the future of education at MIT, we must think about developing the "future citizens" of MIT: students who meet the highest standards of academic excellence and are also able to appreciate the "big picture," understand their technical world in context, make connections across subject content, work collaboratively, communicate effectively, think critically and analytically, think and design creatively, deal with uncertainty and complexity, and nurture humane values. In short, we must complement MIT's excellent technical education and experiential learning with other attributes that position our graduates to be leaders in our future society, inspired to change the world. We already excel in some of these attributes, thanks to a rigorous and demanding curriculum and rich experiential opportunities such as MIT's Undergraduate Research Opportunities Program (UROP), MIT International Science and Technology Initiatives (MISTI), and the Edgerton Center. However, student surveys consistently show that we need to impart better communication skills to our students. The ability to communicate effectively—to advocate and educate, to work in a team, and to transfer relevant domain knowledge from one discipline to another—is a critical 21st-century skill.

14. Sullivan, William M. and Matthew S. Rosin. *A New Agenda for Higher Education: Shaping a Life of the Mind for Practice*. San Francisco: Jossey-Bass; 2008.

UROP is a highly successful program at MIT, embodying our educational principle of learning-by-doing. UROP projects contribute to our students' growth by deepening their technical skills, exposing them to the research process, and building mentee/apprentice relationships with faculty members. Over 85% of all MIT undergraduates participate in a UROP before they graduate, compared to 40% participation in similar programs at other private and highly selective research universities. Building on the success of UROP, we should explore the value of instituting other formal experiential opportunities, reaching beyond technical research experiences to programs that could foster other strengths, such as leadership, an appreciation for societal responsibility, contextualization, and communication. For example, there would be many advantages to instituting companion programs to UROP for teaching and for service.

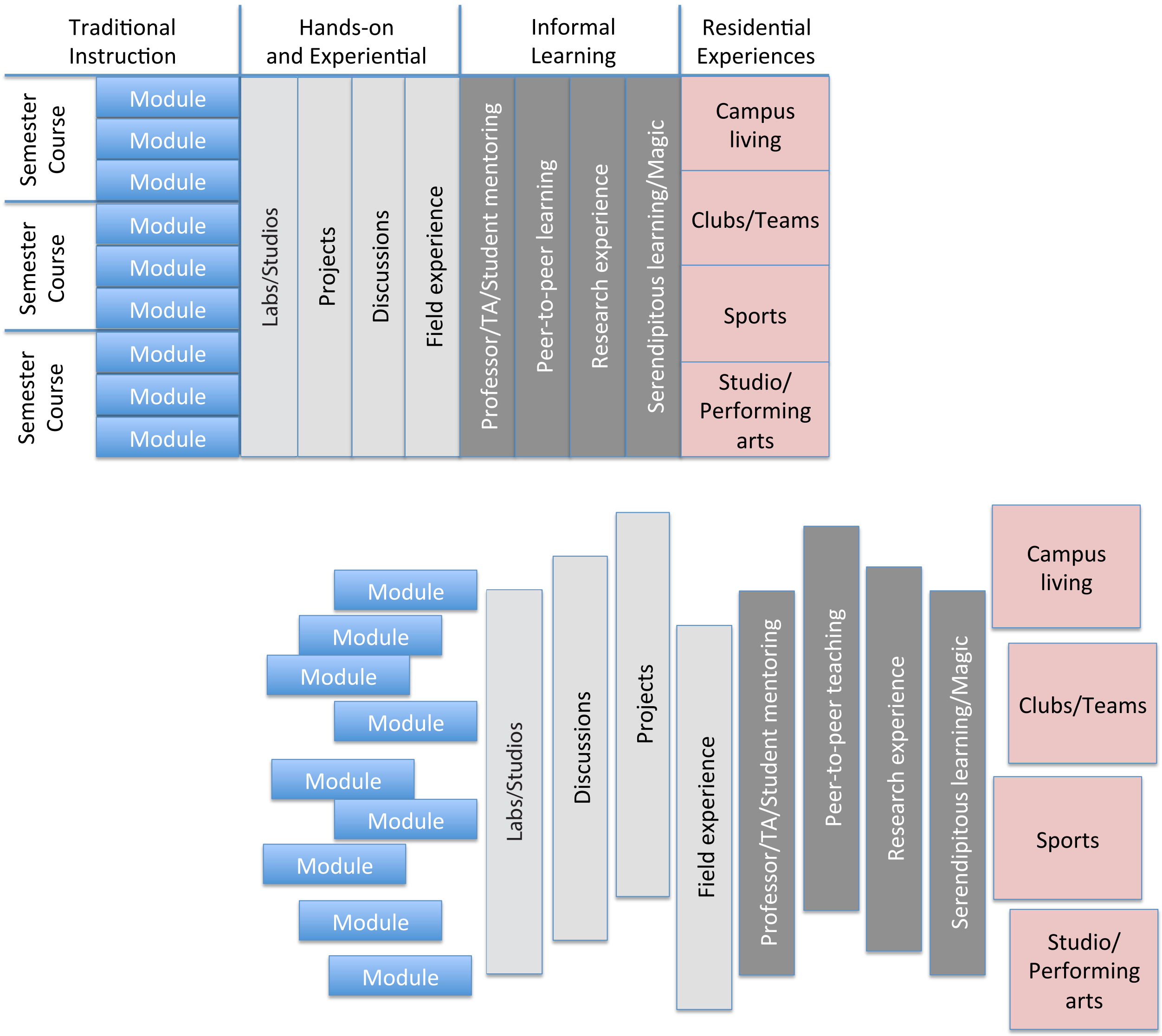
We should also ensure that MIT education and facilities for the future maintain a strong commitment to hands-on experiences and learning-by-doing. Project Athena brought about a wave of innovation in the software realm; could new Maker Spaces together with a reinforced commitment to learning-by-doing create the next generation of tinkerers, fluent in advanced manufacturing and rapid prototyping techniques?

Modularity

Modularity is a key enabler of unbundling (Figure 1) and rebundling in the MIT undergraduate curriculum. We define a module as a self-contained unit comprising a set of outcomes. An outcome is what the student will know or be able to do as a result of a learning experience. Outcomes are intended to drive the instruction and assessment for the module. The size of modules can vary, ranging from an entire class to a portion of a class or a series of lectures. We propose here that a module is defined by its corresponding outcomes.

There is a spectrum of approaches to achieving greater modularity in the MIT undergraduate curriculum, from a top-down approach that decomposes existing courses into modules to a bottom-up approach that re-engineers a curriculum by identifying the core concepts and associated modules that underlie them or build upon them. In addition to providing increased flexibility for students to customize their degree programs, increased modularity also presents other opportunities to improve MIT education and even may address some existing faculty resource limitations. Among the most important opportunities are competency-based assessment, better-defined prerequisite relationships, shared faculty/instructor resources for common content across departments, and an increase in undergraduate teaching opportunities.

Figure 1. Unbundling of education



Spaces and Places

The classroom is evolving from a room-with-a-blackboard to an online forum blended with hands-on activities. Teaching is evolving from speaking at a podium to activities that center on the interactive engagement of students. Assessment materials are evolving from weekly paper problem sets to instantly graded, interactive questions and simulations, with evaluations from multitudes of peer learners. Information delivery is giving way to interactive learning.

The momentous rise of digital learning, on campus and beyond, enabling learning anywhere at any time, inspires us to imagine what MIT's facilities for the future could be—combining online activities with in-person interactions and hands-on experiences. It is exciting to envision *academic villages* that provide environments for enhanced interactions to occur both inside and outside of the classroom and laboratory settings. Composed of classrooms, breakout spaces, study spaces, technical support, food services, and library facilities with integrated faculty offices and laboratories, academic villages are designed to promote serendipitous interactions among students and faculty members.

Villages would be complemented by a system of small, focused *maker spaces* strategically located around campus, further enhancing the experiential learning so integral to an MIT education. Maker spaces build on lightweight rapid fabrication tools and techniques, such as 3-D printers, laser cutters, and open source hardware.

These two ideas—village places and maker spaces—are detailed in the report of Working Group 1 from the perspective of digital learning at MIT. These concepts and additional opportunities to open up grand spaces on the main campus that would accommodate new methods of teaching will be further explored as the Task Force continues its work.

MIT'S INTERACTION WITH THE WORLD

The digital education revolution has the potential to alter the way MIT interacts not only with its on-campus students, but with an entire globe of learners. Working Group 2's report on the global implications and opportunities of edX describes the distinct benefits for traditional learners and for those outside of the MIT campus. In many cases, there are synergies between these two audiences; where the global audience might benefit from increased access to MIT students, faculty, and resources, increased exposure to the world at large would similarly be of value to those on the MIT campus. We describe some of those synergies here.

First, more in-depth interaction with the world will generate massive amounts of data that will allow educators to better understand how different students learn and what methods are most effective in teaching some kinds of on-campus classes. There are both quantitative data, which is easy to pull from the edX platform, and qualitative data, which can be collected from in-person engagement with edX communities as well as from the discussion forums. Perhaps one of the most exciting developments since the launch of edX has been the proliferation of more than 860 local edX communities around the globe. MIT has already begun to build on the success of these communities. For instance, MIT recently ran an experiment with the city of Chicago called ChicagoX, in which MIT alumni served as mentors to students in Chicago who took a computer science class offered by *MITx*. The value of alumni's role in mentoring and coaching students in this kind of setting is clear; there is also great value to MIT. The alumni are able to collect and relay feedback about the students' experience and about the software platform. This kind of engagement strengthens MIT's ties with its alumni, creates new connections with potential MIT applicants, and generates information that could be used to improve *MITx*.

Second, edX presents new opportunities for MIT students to engage in meaningful international experiences while also providing invaluable access to MIT for *MITx* students in local communities. During summer 2013, MISTI placed 10 MIT students trained on the edX platforms in four countries during their internships. The students served as coaches, mentors, and teachers, providing a tangible connection to MIT for the *MITx* learners and creating an opportunity for MIT students to develop valuable skills that could be applied when they return to campus. *MITx* presents the potential for an initiative akin to the Peace Corps by which MIT students would gain hands-on experience interacting with *MITx* learners around the globe, and global learners would benefit from increased in-person interaction with MIT students.

Third, the opportunity to engage with a global audience in new and interesting ways provides more in-depth insight that could be of great value to our faculty in both teaching and research. Again, the benefit to the local communities is clear—access to MIT faculty and curricula is extremely valuable and sought after—but the benefit for those on our campus is equally significant. An instructor would gain immediate feedback, whether direct or indirect, from an audience of thousands of learners, allowing the instructor to immediately strengthen the class for both global and residential audiences. Similarly, increased global access allows MIT faculty to better understand the challenges that most keenly need MIT's attention. Research decisions and pathways are based on exposure to a problem; that is, researchers decide which challenges to address based on what they hear or see. Faculty are already experimenting with education in interesting ways as part of MIT's overall global strategy, through participation with the Singapore University of Technology and Design (SUTD), the Skolkovo Institute of Science and Technology (SkTech), the Masdar Institute, and the MIT Portugal Program. With new avenues for interaction, faculty will be closer to the world's problems, providing greater insight and informing their research decisions.

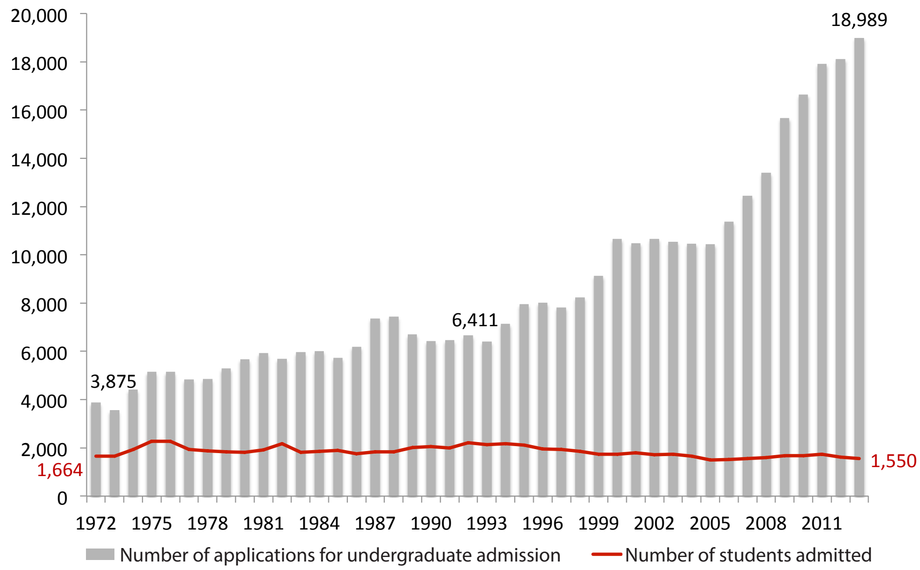
All of these opportunities for engagement with the world hinge on the idea of leveraging increased exposure to large-scale audiences. Through placement of members of our community—whether faculty, students, or alumni—around the globe, we have a greater opportunity to serve the world, strengthen *MITx* and edX, and enrich the educational and personal experiences for the members of our immediate community. The potential benefits of utilizing edX to engage the world are endless.

THE NUMBERS BEHIND AN MIT EDUCATION

MIT graduates contribute to the world in extraordinary ways, but MIT is able to admit only a fraction of the exceptional students who wish to come to campus. Today, MIT educates a little over 11,000 students at any given time.

In 2013, MIT received over 43,000 student applications, and only 10% gained admission to their program of choice. Undergraduate applicants numbered 19,000, and only 8.2% were admitted (Figure 2). By contrast, *MITx* enrolled just over 300,000 unique students in the academic year beginning fall 2012 through spring 2013.

Figure 2. Undergraduate applications and admissions, AY1972–AY2013



Source: MIT Admissions

Presented with these statistics, we must stop to wonder:

- Can we advance the mission of MIT by educating more students?
- Can innovations in online learning improve access and affordability?
- What is the value of an MIT education, residential or online?
- How will the adoption of online learning, by MIT or others, impact the financial model of MIT?
- How has MIT's financial model evolved?
- Is the current model sustainable?

To begin to answer these questions, Working Group 3 has constructed a series of historical data sets related to finances, people, and space at MIT to increase our understanding of how MIT's financial model has changed over time. We are evaluating how students finance their educations, articulating the outcomes of an MIT education, and developing approaches to modeling the scenarios that will emerge from the Task Force discussions. The questions we are trying to answer are complex and nuanced, and further work is needed to provide appropriate and detailed answers. We are developing a financial model that focuses on the Institute's faculty members and their various activities—teaching undergraduates, training graduate students, employing postdoctoral researchers, and raising research funds—to obtain new insights on cost drivers and revenue sources that may help us to better predict and guide MIT's future. We are confident that the best approaches for continuing to enable MIT to carry out its mission for generations to come will emerge through continued discussions and analysis, but we want to share preliminary observations at this early stage.

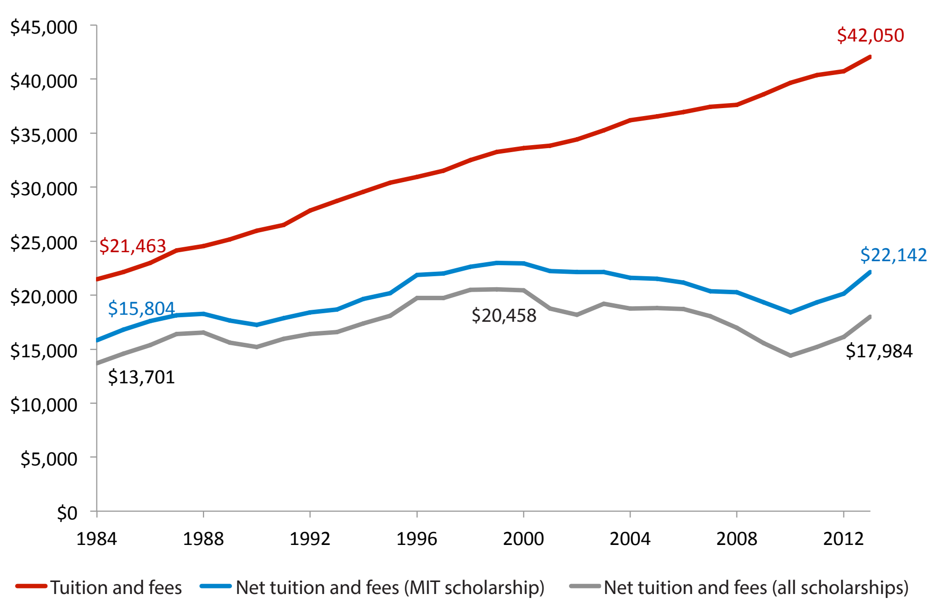
Improved Affordability and Desirability of an MIT Education

As noted above, the public conversation about the affordability of higher education and the impact of cost on access to a college education is growing. While it is true that higher education is expensive, MIT remains committed to need-blind admissions for undergraduates, and to providing those who are admitted with the aid needed to complete their MIT degrees. Nonetheless, the true cost of educating an undergraduate student at MIT is nearly three-and-a-half times the average net tuition (average cost paid by an undergraduate after MIT scholarships). At the same time, the true average tuition paid by an MIT undergraduate today when considering scholarships from all sources is lower in real dollars than in 2000.

In fall 2013, while MIT's tuition rate with fees was $43,498, the average net tuition paid by undergraduates was half that amount, or $22,208, because of MIT's need-based undergraduate scholarship program. More important, the tuition rate is considerably less than the cost of delivering an MIT education. Since 1998 the growth in MIT's undergraduate tuition rate has exceeded inflation, but the growth in MIT's undergraduate scholarship budget surpassed the tuition rate growth. In real dollars, the tuition rate grew about 31% from 1998 to 2013 while the average net tuition paid by MIT undergraduates decreased 3.1%.

The gap between the price of the tuition and fees charged by MIT and the average net tuition and fees paid by students after receiving MIT scholarships demonstrates MIT's commitment to making an MIT education as affordable as possible for students from all socioeconomic backgrounds (Figure 3).

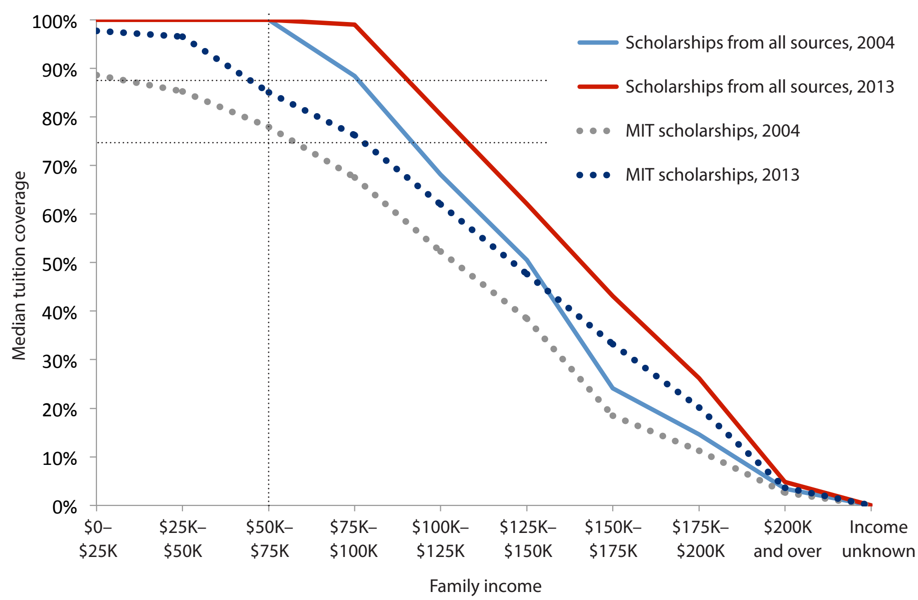
Figure 3. Net undergraduate tuition and fees, AY1984–AY2013 (inflation adjusted $2012)



Source: MIT Student Financial Services

The percentage of students receiving scholarships covering the full tuition price has increased over the past 10 years (Figure 4). During the 2003–2004 academic year, 75% of undergraduate families with incomes of less than $75,000 received MIT scholarships covering the full tuition price. During the 2012–2013 academic year, 88% of families at this income level received MIT scholarships covering the full tuition price.

Figure 4. Median undergraduate tuition coverage by scholarships, AY2004 vs. AY2013 (inflation adjusted $2012)



Source: MIT Student Financial Services

MIT has a significant impact on educating some of the brightest engineers, scientists, and businesspeople of our time, and graduates from MIT have performed exceedingly well in their life pursuits. The average starting salary of an MIT undergraduate upon graduation ($66,800 in 2012) has been consistently higher than the U.S. median family income ($62,035 in 2012). Twenty years after receiving their MIT degree, most MIT alumni across all programs earn between $150,000 and $200,000 per year excluding bonuses, with positive impact on the U.S. economy.

At the same time, undergraduate debt has been dramatically reduced since the late 1990s. From 1998 to today, the percentage of undergraduates borrowing has decreased from 66% to 40%, and the mean borrowed amount has been cut in half, from $22,500 to $11,000.

Edward B. Roberts, Class of ’57 and founder of the MIT Entrepreneurship Center, led a study of MIT-alumni-founded companies. In a 2009 report, “Entrepreneurial Impact: The Role of MIT,” Roberts described the regional and national economic impact of alumni who create their own firms. At that time he estimated that “if the active companies founded by MIT graduates formed an independent nation, their revenues would make that nation at least the seventeenth-largest economy in the world.”[15]

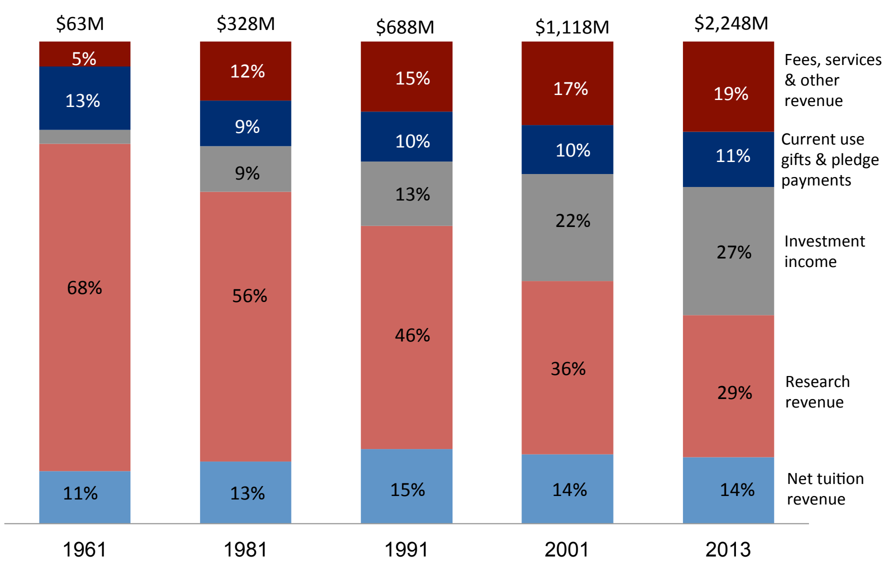
15. Roberts, Edward B. “Entrepreneurial Impact: The Role of MIT,” Kauffman Foundation of Entrepreneurship, 2009.

Sustainability of MIT's Model

By any measure we have studied, an MIT education is increasingly in demand. Paying for an MIT education, however, is costly. Our model today depends primarily on the ability to continue to attract significant research funding and philanthropic support and to generate high real investment returns.

The campus revenue mix has changed significantly from 1961, when research funding comprised 68% of revenue (Figure 5). Sixty-five percent of faculty members have active research programs today, and this percentage has remained fairly stable since 1997. Average research expenditures per faculty member have grown in constant dollars (2013) from $634,103 in 1997 to $815,596 in 2013. Median research expenditures in constant dollars have grown from $323,197 to $476,640 during this same time period. Today, while research expenditures have grown significantly, the percentage of campus revenue has dropped to 29%, with investment income growing from 3% of total in 1961 to 27% today.

Figure 5. Evolution of campus revenue mix, FY1961–FY2013



Note: Excludes the Broad Institute, Lincoln Laboratory, and the Singapore-MIT Alliance for Research and Technology.

Source: MIT Vice President for Finance

MIT has been quite fortunate in competing for available research dollars, attracting the very best students and growing the endowment through philanthropy and market returns. These results have allowed our vibrant research university to flourish beyond its initial conception.

At the same time, we face significant challenges.

1. Constrained federal funding has forced the Institute to grow and diversify its sponsored research portfolio to include greater portions of industrial and international support. As the overall pool of federal research funding shrinks, the mix of campus research

sponsorship changes. Federal funding of campus research has declined from close to 100% 50 years ago to 69% today.

2. Endowment returns and gift flows have typically followed macroeconomic trends, and we face a still-uncertain global economy and implied volatility. Investment support and gifts represent 38% of all campus annual revenues.
3. Academic and research space on campus has grown significantly over the past decades, to 5 million net assignable square feet, in order to accommodate the expansion of research and educational activities. We face the need to maintain and improve a great fraction of our world-class teaching and research infrastructure at considerable expense.
4. We also face the challenge of maintaining competitiveness in the recruitment of top talent without offsetting gains in productivity. This effect, known as Baumol's cost disease,[16] is caused by the need to compete for skilled workers in industries experiencing productivity gains.

Preserving and enhancing MIT's extraordinary research and educational environment is likely to require that we both strengthen existing income sources and consider new revenue opportunities. It may be possible to raise the level of development activity to support increases in charitable gifts, expand the scope of institutional and corporate partnerships, widen the menu of summer programs, and broaden executive education activities. One potential new source of revenue is the use of digital learning technologies to leverage on-campus course instruction, coupled with some form of paid certification. We will need to balance our desire to not limit access with the need to create a sustainable financial model.

The importance of increasing the resiliency of MIT's future financial model is paramount as the challenge is vast. We will need to broaden our revenue base to balance volatility. We will need to increase the efficiency of the MIT educational model without disrupting the outcomes and exceptional quality that characterize an MIT education. We will need to maintain physical laboratories and spaces of a high standard, so that we continue to attract the best faculty and students to keep advancing scientific discoveries, knowledge, and innovation. And we will need to address the challenges of affordability and access, while adopting a financial model that can withstand the impacts of shifts in research funding or significant endowment volatility.

WHAT WE ARE HEARING

As we have worked to engage the community through the Idea Bank, advisory groups, surveys, and face-to-face meetings, we have noticed a tension between, on the one hand, a desire to preserve many of the qualities that define an MIT education and, on the other, a push to make grand, sweeping changes to MIT's very core. We are hearing a desire to achieve greater flexibility in the way we educate students: flexibility in our curriculum, in time-to-degree, and in experiential learning opportunities. Several faculty and students, for instance, have suggested that now is the time to consider eliminating or drastically altering the General Institute

16. Baumol, William J. and William G. Bowen, *Performing Arts: The Economic Dilemma*. New York: The Twentieth-Century Fund; 1966.

Requirements (GIRs). Others feel that the GIRs are more important than ever to produce well-rounded graduates who have the skills to effectively interact with the world at large. Some suggest that MIT will be able to utilize digital learning to shorten its undergraduate program to three years, while others are adamant that reducing the time to a degree would do our students a disservice. Some concerns have been expressed that online courses might impact faculty slots, but rather than replacing the faculty, online courses deployed in blended classrooms can help make a faculty member more effective. Furthermore, launching edX as a not-for-profit, open source effort gives stakeholders an opportunity to drive this mission in a considered and thoughtful way. As we continue our discussions in the coming months, we will work together to balance these views, to openly address concerns, and to blend opportunities into meaningful experiments that will further inform our work.

CONTINUING THE TASK FORCE WORK

Task Force discussions described in this preliminary report represent only the first step in a continuing dialogue. This report describes a number of possible experiments and pilot approaches, and a range of opportunities that MIT may choose to explore. These possibilities, drawn from brainstorming discussions, may include many ideas that should not be pursued. During phase two of the Task Force work, we will examine these possibilities for experimentation more closely, together with feedback from the MIT community. Only then will we be able to fully evaluate these opportunities and prioritize those that hold value for MIT. The magic of MIT and the values and principles that we as a community hold true will guide us in evaluating opportunities and in charting the best path forward for the Institute.

Working Group 1

MIT Education and Facilities for the Future

In short, to stay true to our educational values, we must seize the opportunity to reimagine what we do and how we do it.

—President L. Rafael Reif

THE MAGIC OF MIT

> *The more I think about MIT, the more it presents itself not as a collection of buildings, of professors, of students, of courses, of papers and catalogues, but as a living vital entity—a being with a character, a personality, a philosophy, a mode of action, a heritage of ideas and methods that have made a deep impression on all who come to know it.*
>
> *—Julius Stratton, MIT's 11th President*

There is something special about being a student at MIT, in participating in the institution that is MIT, and in experiencing the spirit of MIT. This special magic is an essence that is intrinsically tied to residential education at MIT and is a hallmark of close student interactions with faculty and staff. This magic originates in the culture of MIT, is embodied by institutional opportunities at MIT, and is at the heart of the society of MIT.

At MIT, students develop the tools they will need to be lifelong learners. They learn how to work in groups, how to extract information from numerous sources, how to deal with uncertainty, and how to develop creative solutions to unexpected problems.

The culture of MIT is driven by its values and principles, as expressed by William Barton Rogers. Four principles guide what we do at MIT: (i) the educational value of useful knowledge, (ii) societal responsibility, (iii) learning-by-doing, and (iv) combining liberal and professional education.[17] These principles are reflected in the institutional features of residential education at MIT, which span the "triad" of research, academics, and community. They are exemplified by (i) the power of learning-by-doing, (ii) innovation in learning, and (iii) learning by teaching. Factors that lead to MIT's excellence include first-rate minds, passion, creativity, diversity, transparency, meritocracy, egalitarianism, and compassion.

Reflecting the *mens et manus* motto, students at MIT engage in the UROP program, lab courses, entrepreneurial endeavors, and apprenticeship experiences both on and off campus, as well as many other opportunities where they learn by doing. Students are involved in advanced research, engage with concepts firsthand, team up with students from other departments to assess marketization of new innovations, research new technologies, and do externships all around the world. In all of these opportunities, students are exposed to real-world applications and issues, connecting them to societal needs and preparing them to be valuable contributors when they leave MIT.

MIT is also a leader in innovative learning, reimagining the educational experience through several longstanding programs and frequent experiments with new pedagogical strategies. This effort is exemplified by the Experimental Study Group (ESG) and Concourse programs, and by efforts such as Technology Enabled Active Learning (TEAL). ESG has been a leader in active learning pedagogy, in which teaching is seen as a two-way process. Classes are self-paced when possible and have frequent student/faculty interaction. Similar to ESG, Concourse offers MIT freshmen small classes focusing on the integration of the disciplines within the broader human framework. The program focuses on the interconnectedness of concepts to provide students a

17. 1996 Task Force on Student Life and Learning report, http://web.mit.edu/committees/sll/tf1.html.

more complete training and view of the world, which runs counter to many current practices that promote hyper-specialization instead. TEAL is probably the most well-known educational experiment conducted at MIT in the recent past. The TEAL class integrates lecture, recitation, and hands-on experiments within a single session. Instructors deliver 20-minute lectures interspersed with discussion questions, visualizations, and pencil-and-paper exercises. Students use animated simulations designed to help them visualize concepts, and carry out experiments in groups during class.

Driven by the principle of societal responsibility, MIT students are encouraged to teach, not just at MIT, but around the world. Two examples of this are programs at the Edgerton Center and the MISTI teaching programs. The Edgerton Center engages students in K-12 hands-on science, technology, engineering, and math (STEM) education through on-site workshops and intensive summer programs for youth, distribution of curricula developed at the Center, and professional development workshops for teachers. MISTI Global Teaching Labs attracts top students looking to share MIT's unique approach to science and engineering education. Select students are matched with foreign high school hosts for three weeks in January. At each location, students prepare tailored courses on STEM subjects that complement the school's curriculum and highlight MIT's hands-on approach to education. Students prepare for their experience through workshops on effective teaching and classroom techniques.

The MIT educational experience is not constrained to institutional learning opportunities. On the contrary, much of an MIT student's education takes place through interactions within MIT's social fabric. These interactions take place in many forms, but many fall under the umbrellas of extracurricular activities, the Independent Activities Period (IAP), and academic villages.

Not only are MIT students excellent scholars, they are also very energetic, ambitious, and enterprising beyond the classroom. The surprisingly large number of student-initiated and student-driven activities and teams on campus proves this. Not primarily initiated by the administration or faculty, and not part of the regular curriculum, these activities are generated and sustained by students themselves. Students enter into extracurricular activities for many reasons, but most do so primarily because they are interested in changing the world and applying their theoretical knowledge to challenging real-world situations.

FUTURE MODELS FOR MIT EDUCATION

Task Force discussions on future models for MIT education encompassed personal and professional development of students, flexibility, modularity, pedagogy, and assessment. As we discuss each item, we describe possible experiments and pilot projects exploiting opportunities both on campus and online. It is important to note that this preliminary report provides a summary of brainstorming discussions, which may include many ideas that should not be pursued. Phase 2 of the Task Force will revisit these ideas together with new input received from the MIT community, and evaluate and prioritize them.

Shaping the Future MIT Graduate

What are the desired attributes for MIT graduates of the future? As we think about the future of education at MIT, we must think about developing the future citizens of MIT: students who meet the highest standards of academic excellence while being able to appreciate the "big picture," understand their technical world in context, make connections across subject content, work collaboratively, communicate effectively, think and design creatively, deal with uncertainty and complexity, and nurture humane values. In short, we must complement MIT's excellent technical education and experiential learning with other attributes that position our graduates to be leaders in our future society.

We already excel in some of these attributes through a rigorous and demanding curriculum and through rich experiential opportunities such as UROPs, MISTI, and the Edgerton Center. On other attributes we can and should do better.

For example, data consistently show that MIT students' communication skills lag those of their peers.[18] The ability to work and communicate effectively in a team is a critical 21st-century skill, as is the ability to transfer relevant domain knowledge from one discipline to another. The resources MIT will need to achieve these goals are grounded in small class sizes for fostering one-on-one instruction in writing and presenting, including support for faculty critique and review. In addition, faculty time must be dedicated to engaging students with broad reading outside of their technical disciplines, such as the news, literature, and serious nonfiction.

Structural modifications are needed to curriculum organization and teaching schedules to promote faculty awareness of connections among courses (especially, but not limited to, Communication Intensive classes as well as synergies across disciplines). To do this effectively, the Institute will need to support dedicated faculty time for cross-departmental faculty engagement and faculty continuing education. And, importantly, we will need to allocate time in students' schedules for "time on task" in the area of communication skills development.

UROP is a highly successful program at MIT, embodying our educational principle of learning-by-doing. UROP projects contribute to students' growth by deepening their technical skills, exposing them to the research process, and building mentee/apprentice relationships with faculty members. Over 80% of all MIT undergraduates participate in a UROP before they graduate.[19] We should ensure that MIT education and facilities for the future maintain a strong commitment to hands-on experiences and learning-by-doing. As discussed in the section Spaces and Places, new maker spaces all over campus, together with a reinforced commitment to learning-by-doing, could create the next generation of tinkerers, fluent in advanced manufacturing and rapid prototyping techniques.

Building on the success of UROP, we should explore the value of instituting other formal experiential opportunities, reaching beyond technical research experiences to programs that

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18. 2011 MIT Enrolled Student Survey, Office of the Provost, Institutional Research.

19. Dean for Undergraduate Education President's Report 2012, http://web.mit.edu/annualreports/pres12/2012.17.00.pdf, p. 60.

could nurture other strengths, such as leadership, an appreciation for societal responsibility, contextualization, and communication.

For example, one can imagine many advantages to instituting a companion program to UROP for teaching: students re-engage with material from the instructor side to deepen understanding, they develop better technical communication skills, they forge mentor relationships with younger students, and in some cases they could contribute to improving STEM education nationwide. The success of peer instruction as a critical component of the learning process in the literature supports the notion that we learn concepts more completely when we are required to teach them.[20] In a teaching role, students have an opportunity to revisit material, understand the details so they can present it in a coherent manner, and contextualize it in the grander curriculum and the real world to make it relatable for their students. Undergraduate teaching opportunities could encompass a teaching experience related to an MIT or *MITx* class. They could also extend into schools within the United States or even abroad, building on successful programs such as the Educational Studies Program (ESP).[21,22]

Another example is a program with an emphasis on service, contributing to the development of future societal leaders. A formal service opportunities program could formally pair students with a faculty advisor to provide guidance and mentoring in the context of a specific service project. Again, such a program would offer opportunities to develop communication and leadership skills, as well as a firsthand appreciation of the value of contributing to society.

There would also be many advantages in establishing a more formal and coordinated Institute-wide program in teaching opportunities for graduate students. Graduate students cite many different motivations for wanting to engage more deeply in teaching:[23] to complement or substitute for TA duties; to obtain teaching experience for academic job preparation; to disseminate one's own research outcomes and build research collaborations; personal fulfillment; and financial incentives. A mechanism to enable graduate students to contribute educational offerings (e.g., delivered over IAP or during the summer, possibly using the edX platform) would tap into the creative resource of graduate (and potentially undergraduate) students as teachers and pedagogical innovators. Classes could be, for example, research-oriented, or tutorials on advanced topics that are hard to find in existing classes.

Successful programs already exist that organize large-scale student-taught classes. One good example is the MIT ESP, whose volunteer teachers (mostly undergraduate and graduate students within MIT) reach hundreds of high-schoolers, through one-hour workshops to semester-long classes. Any effort should build upon and adapt from proven models such as ESP.

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20. Ramaswamy, Shri, Ilene Harris and Ulrike Tschirner. "Student peer teaching: an innovative approach to instruction in science and engineering education," *Journal of Science Education and Technology*, Vol. 10, No. 2, 2001: 165–171, http://www.jstor.org/stable/40186621.

21. Breslow, Lori. "Surveys for the MIT Graduate Student Teaching Certificate Program," 2008–2013, unpublished reports by the MIT Teaching and Learning Laboratory.

22. http://esp.mit.edu/.

23. MIT Graduate Student Council Digital Learning Subcommittee, http://gsc.mit.edu/committees/arc/dls/.

Another largely untapped resource at MIT is the growing postdoctoral population. A formal mechanism by which postdocs can become engaged in educational experiences will be valuable both for MIT classes and for the career development of the postdocs themselves.

Finally, there is a need to better develop our students' ethical skills. This encompasses ethical behavior and academic honesty as it relates to their conduct in education and research—an even more pressing issue with online classes—as well as the broader ethical issues arising in their technical disciplines. A greater emphasis on contextualizing the technical education is one possible way to address this issue.

The following is a list of brainstorming ideas for pilot projects and experiments related to "shaping the future MIT graduate" discussed by the Working Group on MIT Education and Facilities for the Future:

- Encourage the Subcommittee on the Communication Requirement (SOCR) or other relevant body to assemble materials on best practices for teaching effective communication skills as a resource for faculty and staff.
- Support development, deployment, and assessment of online modules on written and oral technical communications that could be used in Communication Intensive subjects across departments.
- Support faculty time for cross-departmental faculty engagement and faculty continuing education on communications skills.
- Explore blended learning models for Communication Intensive classes that enable smaller student-faculty ratios for face-to-face class components.
- Pilot an Undergraduate Teaching Opportunities Program.[24]
- Pilot an Undergraduate Service Opportunities Program.
- Establish an Institute-wide teaching minor at the graduate level.
- Pilot a program for graduate students to contribute mini-classes taught over IAP or summer.
- Pilot a program for graduate students to partner with faculty members to contribute pedagogical innovations to MIT and *MITx* classes.
- Facilitate teaching experiences for MIT postdocs.
- Assess the need for and potential value of establishing an MIT honor code.

Flexibility

More and more, technology is allowing us to customize our environments, our schedules, and our engagement. For example, we no longer need to watch TV shows on a prescribed, cyclical schedule; we can record them for later viewing or watch them online whenever we want. Technology is offering a similar opportunity to customize educational experiences. Just as there is no teaching space or teaching style that fits all academic subjects, there is no one academic trajectory that is optimal for all MIT students. Greater diversity and flexibility could improve the MIT educational experience.

24. Building on a proposal first developed by Professor Travis Merritt and Dr. Lori Breslow in the early 2000s.

To make MIT education more flexible, we should investigate whether departments should be more flexible and adaptable. Should the GIRs be more flexible, for example by allowing Advanced Placement (AP) credit for *MITx* classes or by providing more choices via modularity? In a more flexible educational future, how do we strike the right balance between depth of disciplinary study and cross-disciplinary breadth and "big ideas"?

We could also consider making time-to-degree more flexible. While precedent shows that many students want to do "what others are doing" (the four-year undergraduate program), if more flexibility were available, other standards might emerge with which students could identify themselves. Today, many MIT students could graduate one or two semesters early (e.g., around 25% of MIT freshmen are eligible for early sophomore standing), yet only 5% to 7% do so.[25] Instead of graduating early, our students fill their four years with double majors, minors, UROPs, and international experiences. Some students might prefer to complete their studies in three years, perhaps to reduce financial pressures. Others might want to get an advanced degree in four years.

Our challenge is to use our principles and values to guide us in establishing specific educational outcomes and a qualitative MIT culture to which we aspire. From there, flexibility brings to our students options—options to reduce or extend their time to degree, options to take a year off-campus to undertake research or get relevant professional experience in the middle of their studies, options to engage more deeply in service and teaching opportunities, and options to take classes online over the summer and streamline their programs.

One important question is how this kind of flexibility might impact our MIT culture. As noted above, in the past three years, around 25% of MIT freshmen have been eligible for early sophomore standing; roughly half of those students elect to take it. Roughly 50% of students change their major during their freshman year; around 30% of students even change the school of their intended major.[26] As we consider more flexible models of MIT education, we need to carefully weigh the value of the current common freshman year.

The following is a list of brainstorming ideas for pilot projects and experiments related to flexibility discussed by the Working Group on MIT Education and Facilities for the Future:

- Evaluate the implications and opportunities of offering AP credit for *MITx* classes.
- Explore expanding the offerings of BS/MEng programs, like the 6-P program in Electrical Engineering and Computer Science (EECS).
- Explore opportunities for offering online courses for credit over the summer. This could include classes taken entirely online, as well as classes that combine an online summer portion with an on-campus portion offered in spring or fall.
- Consider bold experiments that permit different tracks within GIRs to give students more flexibility in choosing their degree curriculum.
- Consider bold experiments that permit flexibility in the GIRs through modularity.
- Review faculty policies that restrict innovation in education.

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25. MIT Institutional Research, http://web.mit.edu/ir/index.html.
26. Ibid.

Modularity

We consider here the opportunities associated with greater modularity in the MIT undergraduate curriculum. We define a module as a self-contained unit comprising a set of outcomes. An *outcome* is what the student knows or is able to do as a result of a learning experience. Outcomes are intended to drive the instruction and assessment for the module. Modules can vary in size from a portion of a class meeting to many lectures.

Modularity could be achieved in the MIT undergraduate curriculum in a number of ways. A top-down approach would decompose existing courses into modules; a bottom-up approach would re-engineer a curriculum by identifying the core concepts and associated modules that underlie them or build on them. Because some aspects of the curriculum are more easily modularized than others, modularization should be implemented selectively and carefully.

In addition to providing increased flexibility for students to customize their degree programs, increased modularity presents other opportunities to improve MIT education and even may address some existing faculty resource limitations. Among the most important opportunities are competency-based assessment, better-defined prerequisite relationships, shared faculty/instructor resources for common content across departments, and expansion of undergraduate teaching opportunities.

Flexibility in Curriculum

Introductory classes within many courses are intended to construct a foundation of general department-specific knowledge upon which students can build when they select electives, or even register for graduate-level classes, down the road. Given the soaring popularity in flexible degree programs,[27] however, students are demonstrating a desire to further customize their undergraduate experiences. Offering smaller modules, each focusing on a set of outcomes, will permit students more flexibility in customizing their degree programs. This could be achieved by creating new modules or by decomposing existing classes into smaller modules. Modules could be “vertical”—where module order matters—or “horizontal”—where there are multiple interchangeable orders of learning.

Modularization via decomposition is currently being implemented in the redesigned mechanical engineering flexible 2-A degree program. The new program replaces four traditional 12-unit core courses with eight modular six-unit core courses, thus giving all 2-A students exposure to the full range of subjects considered core to the mechanical engineering degree.

Flexibility in Pedagogy

Modularization also offers flexibility in pedagogy. For example, some aspects of a class may be amenable to online learning or to a particular blended learning model, while other aspects are not. Constructing resources in a modular way offers opportunities to tailor media and pedagogy to the material at hand. It also lowers barriers to faculty experimentation with different media and teaching models.

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27. For example, the flexible 2-A degree has increased tenfold over nine years, http://web.mit.edu/registrar/stats/yrpts/index.html.

Competency-Based Assessment

Currently it is possible for a student to fail a portion of a class and still achieve a passing grade (or even an A or B) in the class. When subsequent classes depend heavily on that prerequisite material, the student is ill-prepared to continue. Greater modularity in the curriculum would permit competency-based assessment—evaluation based on a student's level of mastery on specific capabilities—which could be related to the outcomes comprising a module. This in turn could be used to guide a student's progression through downstream modules.

Prerequisites

Prerequisite relationships can be further delineated with greater modularity in the curriculum. If Class A is a prerequisite for Class B, it is almost never the case that every topic of Class A is a prerequisite for each topic of Class B. In the move to greater modularity, the prerequisite relationships between sections of content in classes will need to be defined in detail. This discovery process will improve students' ability to customize their degree programs, identify commonalities across class offerings, and improve knowledge transfer from upstream classes by raising awareness for faculty and students alike.

Commonalities Across Departments

Viewing content at the modular outcome level, many commonalities exist across classes in different departments. For example, many departments in the School of Engineering offer introductory-level classes on fluid mechanics, each containing essentially the same core material, augmented by department-specific concepts and applications. With greater modularity, the core material can be offered as one module to students across departments, while the department-specific content can exist as separate modules under the auspices of each department. For the common content, faculty/instructor resources can be shared, reducing burden on faculty.

Shared teaching modules could also enhance student learning. The process of reducing the material to its fundamental components would likely reveal multiple ways to present the same material, which could result in materials that reach a wider student audience. Instructors could present concepts in multiple ways—for example, through text, graphics, or illustrations—to reach a wider swath of students effectively.[28] Harvesting the application-specific content and examples would also provide students with examples not only from their own department, but also from other departments, giving students a well-rounded understanding of the core concept and a deeper appreciation for its universality.

Undergraduate Teaching Opportunities

Greater modularity in the undergraduate curriculum may introduce more undergraduate teaching opportunities. Undergraduate teaching assistants are typically chosen from a select group of students demonstrating a high level of mastery of class content. If classes were broken into modules, a student could more easily achieve that high level of mastery on particular

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28. Halpern, Diane F. and Milton D. Hakel. "Applying the science of learning to the university and beyond: teaching for long-term retention and transfer," *Change*, Vol. 35, No. 4, 2003: 36–41.

modules, resulting in many more opportunities for students to teach and thus reinforce and deepen their learning.

Brainstorming Ideas

The following is a list of brainstorming ideas for modularity-related pilot projects and experiments discussed by the Working Group on MIT Education and Facilities for the Future:

- Modularization is already happening in many departments around the Institute (e.g., Mechanical Engineering, EECS). Explore how to take a more strategic approach to identifying modularization opportunities, including opportunities that cross departments.
- Explore further opportunities for synchronous modularization, which is already used in Sloan, Physical Education, and Literature. Are there concerns with pace and pressure issues?
- Revisit Institute rules, e.g., on REST subjects. Is there an advantage to permitting four 6-unit REST subjects vs. two 12-unit subjects?
- Explore how modularity might impact the graduate curriculum through minicourses, which are currently being considered in Brain and Cognitive Sciences.

Transforming Pedagogy: Contextualizing, Connecting, Blending, and Assessing

In combination with new pedagogies, unbundling and modularity permit rebundling of an MIT education in new and interesting ways. They provide an opportunity to emphasize connections and to achieve greater contextualization and "education for practical reasoning".[29] These opportunities are enabled through a combination of digital learning technologies and face-to-face pedagogical strategies. Achieving them will require a commitment to adopting new models of blended learning and an investment in diverse typologies of spaces that cater to different formats of learning. As we transform our pedagogies, it is also an important opportunity to explore new approaches to assessment.

Contextualizing—Understanding the Technical World in Context

MIT alumni contribute to the world in many different ways. Future MIT education must reinforce our commitment to the value of societal responsibility, emphasizing how MIT students can use the gift of their education to make the world a better place, and helping to create the principled leaders that humanity needs. Contextualizing what students learn is an important part of achieving this. Students should understand the societal impact of their decisions and appreciate the ethical considerations that guide those decisions. This could be achieved in part through an increased emphasis on weaving societal impact and ethical considerations throughout the technical MIT curriculum. Modularity and rebundling could be a path to better integration of HASS subjects with science and engineering subjects, resulting in an education that remains rigorous but emphasizes the connection to and the value of humanities. Modularity combined with online modalities also opens the possibilities for more

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29. Sullivan, William M. and Matthew S. Rosin. *A New Agenda for Higher Education: Shaping a Life of the Mind for Practice*. San Francisco: Jossey-Bass; 2008.

open-ended, big-picture projects rather than focusing in narrowly on class-specific problem solving (e.g., through projects conducted off-campus in an immersive contextual experience).

Connecting—Across Concepts and Across Departments

If we move toward greater modularity with unbundling, it will be important not to lose the connections among concepts, ideas, and tools. In fact, greater modularity should not break apart the curriculum into standalone pieces but rather elucidate the connections between them. There are already some attempts to draw out connections between components of classes across the Institute (e.g., crosslinks, EECS Curriculum: A Dynamic Graphical Display). By providing advanced recognition of downstream requirements, students will appreciate the importance of what they are currently learning. In downstream courses, students can link back to prerequisite material to refresh their memories.

Identifying linkages among concepts may also reveal commonalities among classes across departments. For example, many departments in the School of Engineering and some in the School of Science offer sophomore-level classes on fluid dynamics. Each course covers essentially the same foundational material, but with applications that differ among the departments. These common concepts can be covered jointly by a number of departments, which would allow some cross-fertilization of the main concepts among students from several disciplines. As more departments adopt flexible degrees, exploiting these common elements may become more relevant and useful.

Blending—Leveraging Online Technologies Together with an On-Campus Experience

Unbundling and modularity offer new opportunities in digital learning. In particular, blended learning models that include presentation of material entirely on-campus, entirely online, and anywhere in between will improve flexibility for students and faculty. Use of blended learning at a modular level also creates an opportunity for faculty to engage in the digital production process with smaller and more manageable units of content. Offering some modules entirely or mostly online would help students pursue opportunities off campus, such as starting a company, gaining valuable work experience, or performing community service. Offering portions of modules online would free up time in face-to-face class meetings in which professors could explore more active learning exercises.

Incorporating digital technologies through blended learning models would also enable more educational research. Blended learning supports different learning styles, as students choose the modality that best suits them, but it is yet unknown whether blended learning is more or less effective than traditional formats; we still have much to discover.

A further challenge is in finding effective ways to bring hands-on experiences to online learning. Virtual and online labs offer expanded access to machinery and equipment and remove the need to be on campus. Virtual labs are simulations that visualize physical phenomena. Online labs (or iLabs) provide an interface to remote machinery and equipment. MIT's roster of virtual and online labs is extensive (it includes classes in courses 2, 4, 5, 6, 7, 8, 10, 20, 22, and MAS) and should continue to grow.

Assessing—Exploring Competency-Based Assessment

What new assessment strategies become available with a move toward unbundling and rebundling in MIT education? With competency-based assessment, students are evaluated on specific abilities that can be related directly to the measurable outcomes for a class or module. Evaluating students at the module level, in coordination with better understanding of prerequisite relationships between modules, can help students and advisors understand students' preparedness for subsequent offerings. Competency-based assessment, as well as other new assessment strategies, will be explored further before the final report.

Brainstorming Ideas

The following is a list of brainstorming ideas for pilot projects and experiments related to "transforming pedagogy" discussed by the Working Group on MIT Education and Facilities for the Future:

- Consider having an "e-learning week," an experiment run annually in the past five years by the National University of Singapore, in which many or all classes are offered online for the week.[30]
- Provide support across the Institute for preparing new courses/modules utilizing blended learning models: encourage sharing best practices among faculty, give general guidelines at the departmental level, and foster and incentivize faculty collaboration.
- Create a mechanism to encourage and support faculty in proposing "real" educational experiments with definitive outcomes, with the caveat that there are many methods to assess outcomes and not everything can be assessed by A/B experiments. Care is also needed on metrics, in particular to distinguish between short- and long-term gains and to guard against compromising authentic learning for better test scores, or compromising enjoyment or socialization.
- A possible experiment could identify narrower vs. broader concepts (e.g., in physics) and assess concept type pairing with media types.
- Have an anthropologist study ESG/Concourse vs. a regular freshman class.
- A possible experiment could assess live lectures vs. online prerecorded lectures, and look narrowly at knowledge gain.
- A possible experiment could assess the benefits of calling out the conceptual linkages and relationships between upstream and downstream classes. For example, a number of MIT classes could be broken down each into a number of modules, and the prerequisite relationships among each module from class to class identified. Extra competency-based assessment of students for each of the modules could indicate whether performance on prerequisite modules is an indicator of performance on subsequent modules.
- Pilot an Educational Innovation Initiative, fueled and run by students.

30. http://www.cdtl.nus.edu.sg/tech-in-he/.

Design-Oriented and Project-Based Learning Experiences

Many of the best learning experiences occur when students are engaged in design-oriented, project-based activities—going through an iterative process of developing, testing, and refining prototypes. MIT has been a leader in providing students with opportunities to engage in design-oriented projects, from the design competitions in Mechanical Engineering to the capstone projects in Aeronautics and Astronautics to design-oriented UROP projects across the Institute. MIT has also led in the development of new technologies to support design-oriented, project-based learning. For example, the ideas and technologies underlying the LEGO® MINDSTORMS™ robotics kits, now used by millions of students around the world, were developed at MIT and first tested in MIT robot-design competitions during IAP in the 1990s.

As MIT develops new online courses and activities, for use inside MIT and around the world, it should build upon this tradition of design-oriented, project-based learning. Many of today's MOOCs focus primarily on delivering video-based instruction to large numbers of students. MIT should aim to develop its own distinctively-MIT approach to online education, not simply by adding MIT content to MOOCs (though that is, in itself, an important contribution), but also by exploring ways to integrate design-oriented, project-based experiences with online learning. The ultimate goal is to create online experiences that are firmly aligned with the principles, values, and strengths of MIT education.

Online On-Demand Graduate Education

Graduate education differs from undergraduate education in at least three significant ways. First, graduate students often enroll in classes to learn material required to advance their research. As a result, the demand for many graduate-level classes is intermittent and sometimes time-sensitive for students. Second, since graduate-level classes involve specialized advanced topics, the enrollment for classes is much smaller than most undergraduate classes. This leads to some classes being offered every other year, resulting in long wait times for some students. Third, graduate students are often more motivated learners, since they have greater flexibility to select their courses than undergraduate students.

Many graduate-level courses would benefit from online incarnations in which students could engage with the material on demand. Furthermore, with content experts in these specialized areas spread across the country and the world, sharing teaching resources among peer institutions would enrich the MIT graduate curriculum and allow graduate students to learn from the leaders of the field in a wider variety of topics. These and other ideas will be further explored by the Task Force, building upon the recommendations of the recent report from the Task Force on the Future of Graduate Education in the Context of *MITx* (TFGEM).[31]

31. http://odge.mit.edu/about/committees/sponsored-by-odge/future-grad-ed/.

SPACES AND PLACES

> *When colleges and universities build, they don't just add to their inventories of floor space. They reveal—sometimes unwittingly—their prevailing values, aspirations, and preoccupations. Campuses are evolving, continually contested representations of the communities they house.*
>
> *—William J. Mitchell, in* Imagining MIT: Designing a Campus for the Twenty-First Century, *2007*

How should spaces and places at MIT evolve to support, and build upon, future directions in education on campus? The 2012 Report of the Working Group on the Future of Campus Teaching and Learning Spaces (Professor John Brisson, chair) carefully and thoughtfully addressed this question. Following this, in fall 2012, MIT announced *MITx*, a major new initiative seeking to expand access to education for students worldwide through online learning, while reinventing campus education through blended models. In its first 18 months, *MITx* educated over a million students in 190 countries. On campus, over 2,000 MIT students, and two dozen classes, have now used *MITx* for a wide range of learning activities, from individual problem sets to full flipped courses.

The momentous rise of digital learning, on campus and beyond, motivates a second look at facilities for the future of MIT. This working group presents two findings. First, the main recommendation of the Brisson Report, that MIT focus its renovation plans on developing "academic villages," is timely and prescient in the new light of digital learning. Second, MIT's anchor in the tide of online learning is its dedication to hands-on work; sustaining this calls for establishment of a system of "maker spaces" to ensure that experiential learning remains deeply tied to the lifeblood of education on campus.

These two ideas, village places and maker spaces, are detailed below, from the perspective of digital learning at MIT.

MIT classroom photo, Andrew Chen, 2001.
Stata Center Student Street photo, Daniel Jackson.

Academic Villages

Boundaries between traditional learning spaces and informal learning places have long been shifting at MIT, driven inexorably by the growing ubiquity of information access and the advent of digital learning tools. The classroom is evolving from a room-with-a-blackboard to a laptop with a network connection to the cloud and an online forum—blended with in-person hands-on activities. Teaching is evolving from podium-based knowledge broadcasting to interactive small-group discussion. Assessment materials are evolving from weekly paper problem sets to instantly graded, interactive questions and simulations, and evaluations from multitudes of peer learners. Training is giving way to apprenticeship; information delivery is giving way to interactive learning.

Above all, there is a blending of approaches, and a richness of variety and experimentation. In flipped classrooms, students watch lectures beforehand and meet with the instructor for discussions and problem sessions. Blended classrooms explore everything in between: administering assignments online but retaining traditional lectures, for example, or combining video lectures with in-class experimental design lab sessions among small student teams.

This evolution poses institutional challenges for spaces and places. What kinds of classrooms best support such blended learning? How are classrooms best configured to support discussions and teamwork? Where should classrooms be located to accentuate and grow the magic of on-campus (versus online) education?

The answer proposed by the Brisson Report is the *academic village*:

> A village could include classrooms, breakout spaces, study spaces, technical support, light food services and library facilities. Faculty offices and laboratories could be integrated into and about these spaces. A village should be designed to promote serendipitous interactions between students and faculty members, inviting and attracting students and faculty to linger and work in the academic areas of campus rather than withdrawing to their more distant living spaces. These spaces should support pre- and post-class conversations.

This idea—that blended learning needs blended spaces—is prescient. As the Brisson Report observes,

> Research into Science, Technology, Engineering, and Mathematics (STEM) teaching and learning over the last several decades has led to a new understanding … that learning is a dynamic process, and that when students are actively involved in their own learning, that learning improves. This leads the Working Group to believe that there will be demands for different kinds of classrooms in the future.
>
> A number of pedagogies have been developed based on this new paradigm. Together, these methods are sometimes referred to as “active learning” or “pedagogies of engagement.” They include peer learning, problem-based learning, project-based learning, service learning, or student learning communities. As a group, these pedagogies require spaces that are more flexible and configurable than traditional lecture halls have been.

Here, we call out three specific points from the Brisson Report that gain near-term urgency in light of digital learning:

1. *MITx* is projected to grow substantially, and the digitization of course content is significantly enabled by low-cost, self-service video (and whiteboard) lecture capture. This capability should be widely available, among a large range of classrooms in and near academic villages, in contrast to existing distance education classrooms, which are expensive to use, hard to book, and isolated from informal communities.
2. Blended teaching experiments will likely grow in number, and will require classrooms different from the traditional. The most effective format for such experimental learning environments has been the TEAL classroom. It is recommended that two to three TEAL-style classrooms, each seating 60 to 80 students, be constructed. These should be strategically located throughout the campus; be flexible, comfortable, and easily configurable; be integrated into academic villages; and be available after class hours as student study space.
3. Residential campuses like MIT's increasingly need to deepen the connection between student residences and campus education. Surveys show that an increasing amount of learning is happening in dorm rooms and common areas due to the accessibility of course content online. The apocryphal story of an undergraduate who earned five degrees in four years by holing up in his Burton-Conner dorm room, leaving only for exams, may become a more common reality, in the absence of stronger academic ties to residences. Build a vibrant West Campus academic village. Elevate the locale around the Stratton Student Center to provide formal as well as informal learning.

Maker Spaces

Virtualization of learning increasingly draws students away from the hands-on activities that are core to MIT's values. MIT's founding idea, *mens et manus*, combining principled understanding with mastery of practical application, underlies the primacy of Institute laboratory courses and experiential learning opportunities on campus. However, labs are increasingly turning into simulations (e.g., 6.004 and 6.111, which both now revolve around software), and students increasingly enter and graduate from MIT having mastered far fewer practical skills, as memorialized by a video documentary[32] showing fresh MIT engineering school graduates struggling with how to wire up a light bulb to a battery.

Today, we face an increasing challenge in giving our students the knowledge and experience of reducing theory to practice, given the rise of digital learning. How many MIT students can readily make a computer control the lights in a room? Or build and connect sensors to gather environmental data? There is great excitement and desire among our students for learning such real-world skills, and need from faculty for such skilled students, particularly for UROPs. Today, the number of student users of the Edgerton Shop and the Hobby Shop are at all-time highs, and the number of users of the Media Lab shop has grown by an order of magnitude in the last decade. However, at the same time, many shops around MIT sit unused or are being

32. Schneps, Matthew H. and Philip M. Sadler, *Minds of Our Own*, Harvard-Smithsonian Center for Astrophysics, 1997 [DVD].

decommissioned, while many student activities such as the Solar Electric Vehicle Team have had to move off the main campus for lack of space.

The tide of online learning may engulf MIT in the next decade, but our educational principles and values can be held steady given an anchor in experiential learning and practical arts. The anchor proposed is a system of *maker spaces*.

Maker spaces are places for communities of people who have a passion for making things, and who want to share that passion by making with others. Crucially, maker spaces build on lightweight rapid fabrication tools and techniques such as 3-D printers, laser cutters, and Arduino microcontrollers, in contrast to traditional machine shops housing heavy equipment such as lathes and milling machines. In fact, maker spaces are to traditional machine shops much as early Athena clusters—with mini- and microcomputers—were to central computing facilities.

Maker spaces focus on personal fabrication and, importantly, on innovation and "experimental play":[33]

> The JPL managers went back to look at their own retiring engineers and … found that in their youth, their older, problem-solving employees had taken apart clocks to see how they worked, or made soapbox derby racers, or built hi-fi stereos, or fixed appliances. The young engineering school graduates who had also done these things, who had played with their hands, were adept at the kinds of problem solving that management sought. Those who hadn't, generally were not. From that point on, JPL made questions about applicants' youthful projects and play a standard part of job interviews. Through research the JPL managers discovered that there is a kind of magic in play.

This kind of experimental play with cutting-edge technology was exactly what Project Athena enabled at MIT in the 1980s. It gave students a chance to play with personal computers, unleashing a torrent of creativity heralding the modern age of software.

Project Athena fishbowl, circa 1988. Photo: Isaac Chuang.

Maker spaces at MIT could bring to personal fabrication, in the next decade, exactly what Project Athena did for computation at the end of the last century. Maker spaces around the world are now providing

33. Experimental play as described by Stuart Brown and Christopher Vaughan in, *Play: How It Shapes the Brain, Opens the Imagination and Invigorates the Soul*. New York: Penguin; 2009.

hobbyists and students with the means and experience to access cutting-edge personal fabrication technology. This technology has deep roots at MIT. This is where one of the first 3-D printers was created, one of the leading waterjet cutters was invented, and the software tools for Arduino-class microcontrollers were first envisioned. And much of this spirit is inspired by the "How to Make Almost Anything" course taught at MIT, which teaches fabrication skills to students of all backgrounds.

Imagine a system of maker spaces at MIT. A series of small, focused maker spaces is strategically located around campus (much like early Athena clusters). These may be general-purpose, located within an academic village, providing a suite of standard rapid fab equipment; their purpose would be to get students started and to feed growing efforts into larger and more specialized shops such as the Hobby Shop (in the Stratton Student Center), the Edgerton Shop, and the Media Lab shop, which are some of the best "organically grown" maker spaces at MIT. All the spaces would be maintained either centrally or by departments, labs or centers, with particular care to student safety and with strong ties to courses and student activities.

Working Group 2

The Future Global Implications of edX and the Opportunities It Creates

Today, I ask that this Task Force be bold in experimenting with ideas that would both enhance the education of our own students on our own campus and that would allow us to offer some version of our educational experience to learners around the world.

—President L. Rafael Reif

INTRODUCTION

The digital revolution can be felt across a number of industries, from publishing to media to retail. While the adoption of digital technology presents its own set of opportunities and challenges in each industry, several overall trends have surfaced across the spectrum. First, and most obvious, is the massive scale of adoption. YouTube, for example, claims a viewership of over one billion unique viewers and over six billion hours of video watched every month, with 70% of the traffic originating outside the United States.[34] Second, the industries have seen increased potential and demand for disaggregating, or unbundling, their products. Newspapers, for example, have become disaggregated into individual articles available piecemeal online. These are often curated and aggregated by other online sites such as The Huffington Post or Drudge Report. Apple unbundled albums into 99-cent songs, and users aggregate individual songs into playlists. Third, traditional boundaries in various media and platforms are becoming less distinct, creating new opportunities and greater potential for collaboration. The availability of online video through YouTube, iTunes, Hulu, and other sources, for example, has blurred the boundaries between traditional television programming, cable, computers, and mobile phones. Telecommuting blurs the line between offices and homes. Online retail has blurred the boundaries between brick-and-mortar stores such as Walmart, e-commerce sites such as Amazon, and auction sites such as eBay.

The digital revolution has transformed how our students communicate, access information, conduct research, and collaborate. However, until recently, the impact of the Internet on the framework of higher education, which pioneered many of the digital technologies that have impacted the world, has been relatively minimal. Online education itself is not new. Massive open online courses (MOOCs), however, are less than 10 years old. MOOCs represent a new phase in the evolution of online education because they address student populations at a scale inconceivable even five years ago. MIT's launch of *MITx* and edX marked the entry by traditional not-for-profit residential universities into the realm of MOOCs in an emphatic way. Many of the trends that have affected other industries are becoming relevant to institutions such as MIT. We examine the implications in this report.

EdX has already enabled MIT professors to reach hundreds of thousands of students in a year, a number that exceeds MIT's student population by more than an order of magnitude. An MIT professor might reach more students in a single edX class than in a lifetime of conventional teaching. This creates opportunities and implications not unlike those faced by other industries affected by the digital revolution. Meanwhile, the demand for education—as a basic human need—continues to grow. Over 400 million individuals of tertiary-education age around the world aren't enrolled today. Meanwhile, the value of education in developing individuals, cultures, and societies is unquestioned. Simply stated, educational access is an important global need.

Reaching out to the global community has repercussions for all facets of MIT. The MIT community engages in a variety of activities—undergraduate education, graduate education, research, thought leadership, extracurricular activities, innovation, entrepreneurship, technology transfer, and international collaborations, to name a few—and each of these may both contribute to and be impacted by the global implications of new digital learning

34. http://www.youtube.com/yt/press/statistics.html.

technologies. We address four strategic implications of digital technology on MIT: implications of *MITx* and edX on the world, opportunities for MIT resulting from engagement with the world, implications of disaggregation on residential and online education, and possible implications of blurred boundaries on MIT.

IMPACT OF *MITX* AND EDX ON THE WORLD

The range of innovations possible can be understood by considering three broad sets of options: the different audiences for *MITx* classes delivered over edX, the different modalities by which students could learn the material, and the different outcomes to which students could aspire. We examine each below.

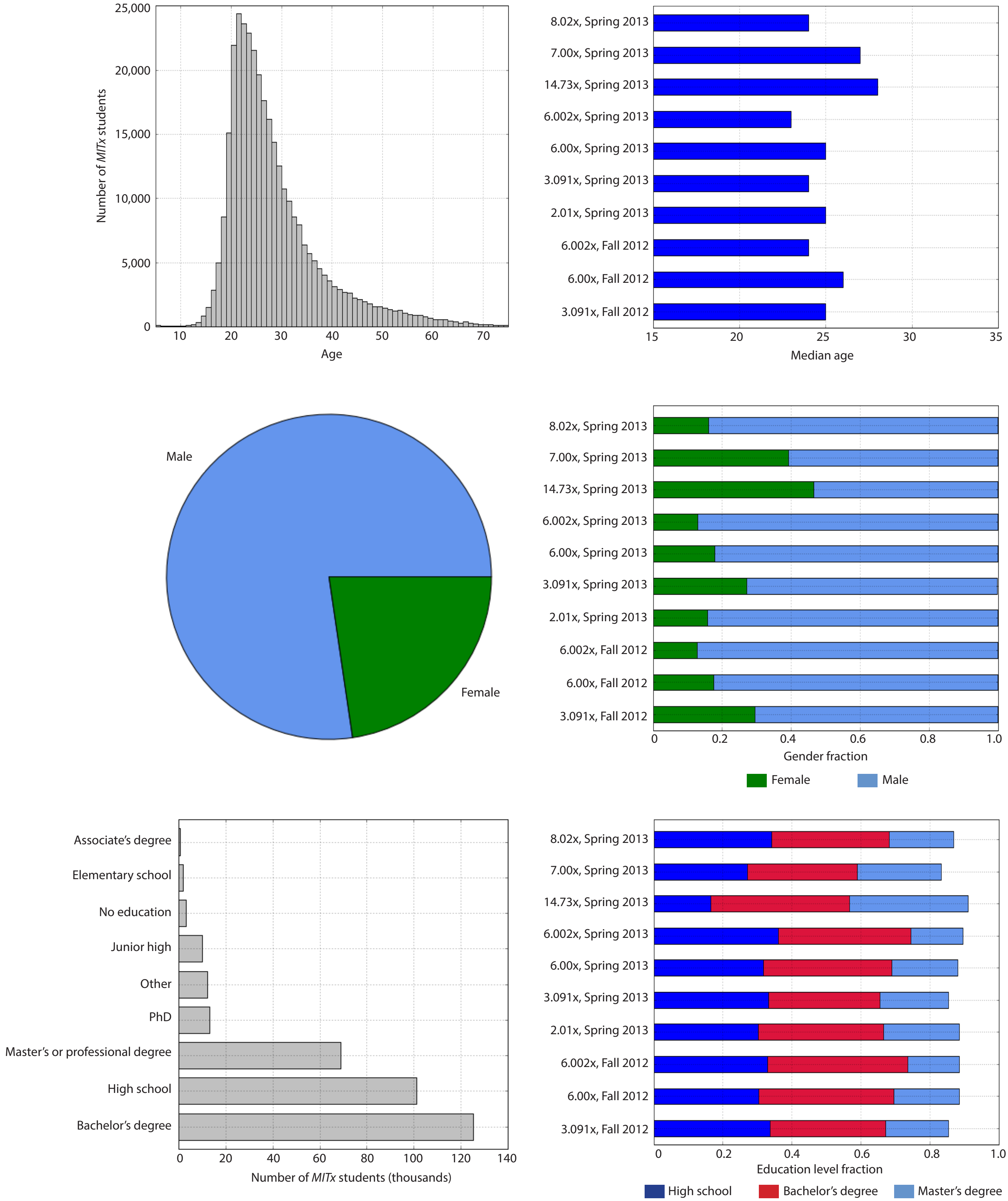
MITx Audience Demographics

Figure 6 shows the demographics of *MITx* students from fall 2012 through spring 2013.

Although all of the classes are at the undergraduate level, the median age of the overall population is about 25, and the mode is 21. A further examination of the highest undergraduate degrees attained by students prior to taking *MITx* classes indicates that a substantial number of students study online while they are working—either for professional development or simply to "catch up" with the latest thinking. Primary and secondary school teachers are another demographic whose role will be affected significantly in the years ahead. Already, 8.MRev, offered by *MITx* over edX in summer 2013, offered continuing education unit (CEU) credits to U.S. high school teachers. With these insights, and with anecdotal information gathered from surveys, we segment the student population as follows. We specifically do not consider MIT students in this section—we will look at MIT students later.

- Primary and secondary school students
  - While embedded in school
  - Self-learners
- College students outside MIT
  - Through the college/university
  - Self-learners
- Professionals (MIT alums or other)
  - Working professionals learning materials through their companies
  - Self-learners
- Educators
- Individuals seeking personal enrichment

Figure 6. Demographics of *MITx* classes, fall 2012 to spring 2013



All figures courtesy Daniel Seaton and Isaac Chuang, MIT.

Examination of the surveys submitted by edX students reveals a few other motivations that are only partially covered by the classification above. For example, a few students in countries such as Russia who are very familiar with physics might enroll in a physics class to practice English instead of physics. These groups are small, and we set them aside for the time being.

The demographic data also show that a majority of the students were male. Of the classes, two had significantly higher female fractions: 14.73x, The Economics of Global Poverty, and 7.00x, The Secret of Life (a biology class). Furthermore, of the classes listed, only two had female instructors: 14.73x and 2.01x. None of the classes was taught by a member of an underrepresented minority group. These issues will need to be addressed in upcoming offerings of *MITx* classes. It will be important for classes offered on *MITx* to represent the diversity that makes MIT a special place.

MITx Delivery Modalities

The typical *MITx* class offered on edX involves videos, assessments (which may range from multiple-choice questions to games or simulations such as protein folding), and links to other resources, all of which are online. However, other modalities are also possible, and we examine them below.

Hands-On Experiences

The Institute-wide Task Force was fortunate to benefit from the work of an earlier *MITx* task force on hands-on activities chaired by Professor Jesús del Alamo, which described a number of hands-on elements that could be introduced to students taking *MITx* classes through edX around the world. There are two approaches here: remote labs, such as MIT's iLabs concept, and home kits for edX students to perform experiments or build units wherever they are.

iLabs are real labs that can be manipulated over the web.[35] Students can log in to an iLab and perform experiments such as testing the performance of an RC circuit. A real RC circuit runs in the background, connected by instrumentation to the interface the student sees, often including a video camera pointed at the experiment.

Home kits are not new, and they can be purchased in most educational supply facilities. Our proposal, however, is to develop advanced home kits for classes such as chemistry and robotics with which students can perform advanced design and experimentation. An example of such a kit might be the LEGO® MINDSTORMS™ robotics kit, of which a key developer was Professor Mitchel Resnick, a member of the Institute-wide Task Force.[36] It is conceivable that *MITx* classes taught through edX could be linked to activities on home kits. Although these kits might be too expensive for individuals, they could be made available through schools, colleges, and libraries. Such possibilities may enable online education to bridge the gap between the online world and real-world experiences.

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35. Harward, V. Judson, Jesús del Alamo and Vijay Choudhary. "iLab: a scalable architecture for sharing online experiments," International Conference on Engineering Education, 2004.

36. Martin, Fred, et al. "To Mindstorms and beyond," *Robots for Kids: Exploring New Technologies for Learning*, Morgan Kaufmann, San Francisco, 2000: 9–33.

Local Fabrication and Partner Universities

The advent of 3-D printing has galvanized a new community of manufacturing and hobbyist aficionados who refer to themselves as makers. We recognize the importance of this movement and the opportunity to leverage it to encourage learning. Maker facilities are now developing around the world. In particular the fab lab consortium spearheaded by Professor Neil Gershenfeld has installed fab lab maker facilities at over 200 locations around the world, including Jalalabad, Afghanistan, and Paramaribo, Suriname.[37] These facilities can be incorporated into *MITx* curricula to enable students to gain the hands-on experience so important to MIT's *mens et manus* ideals.

The idea of local fab labs can be expanded to include local universities. MIT has several university partnerships around the world. *MITx* classes could be taught in collaboration with MIT and xConsortium partner universities so that students could receive hands-on instruction at these facilities.

The iLab and fab lab models directly challenge our traditional notions of educational supply and demand in two ways. First, labs are expensive to maintain and run, but an iLab arrangement allows institutions to share labs. The time and expense associated with configuring lab experiences can suddenly become more widely distributed, and the latencies in lab usage are reduced. Overall, we can see the implications for positively affecting the economics of education through the availability of lab experiences at much higher magnitudes, including more sophisticated labs and more lab time to users. Second, these types of initiatives facilitate the creation of communities of learners around the world who access the same labs, exchange ideas, and bring new contexts into the learning space. It is a very powerful shift, and it represents the type of pedagogical change that open initiatives can enable.[38]

Alumni, Mentors, and Local Learning Communities

Early experiences with edX taught us that students seek community. Communities first formed in online forums but quickly moved to physical "meetups" in places as diverse as Cairo and São Paulo. There are over 860 known local communities around the world today (shown on a map in Figure 7) that are managed by edX through a community organization function. The thirst for interpersonal interaction is also not surprising given the literature on the topic.[39]

MIT alumni can play an important role in these communities by acting as nucleating agents and catalysts, and serving both as anchors to the community and as coaches and mentors. Partner universities could also play a role in this regard.

In fact, we have already tested this idea through a project with the city of Chicago called ChicagoX. MIT alumni acted as mentors to students in Chicago who took a computer science

37. Gershenfeld, Neil. "How to make almost anything: the digital fabrication revolution," *Foreign Affairs,* Vol. 91, No. 6, 2012: 58.

38. Kumar, Vijay, "The new landscape for innovative transformation of education," *Social Research: An International Quarterly*, Vol. 79, No. 3, 2012: 619–630.

39. Mackey, Katherine R.M., and David L. Freyberg. "The effect of social presence on affective and cognitive learning in an international engineering course taught via distance learning," *Journal of Engineering Education* Vol. 99, No. 1, 2010: 23–34.

Figure 7. EdX communities worldwide, November 2013

Source: http://www.meetup.com/edX-Communities/

course offered by *MITx* through edX. The experiment was a success, with alumni reporting mostly good experiences and a willingness to try again. The alumni were also able to give MIT constructive feedback about the experience and about the software platform. We intend to try a larger-scale experiment in spring 2014.

MIT students can also benefit by visiting learning communities around the world, acting as local coaches and mentors and creating a sense of connection with MIT. We experimented with this in summer 2013, when 10 MIT students trained on the MISTI (MIT International Science and Technology Initiatives) platform visited four countries and acted as *MITx* ambassadors during their MISTI internships. We believe this form of learning by teaching will be a new and growing opportunity for MIT students in the same way that the Peace Corps was a generation ago.

MIT/Partner University Visits

It is also conceivable that students who take *MITx* classes could visit MIT for an intensive weeklong class or a summer camp. The idea of campus visits could also be extended through xConsortium partners; for example, a student taking an *MITx* class from China could visit a Chinese xConsortium partner university. This idea could also be combined with the idea described above, so that MIT alumni or current MIT students would participate in intensive camps that provide enhanced coverage, hands-on activities, and discussions about the topics being taught.

Outcomes of an *MITx* Class

There are many possible outcomes of an *MITx* class. A basic outcome is personal enrichment. The desire for this is already borne out by the success of OCW, which receives over two million visitors a month. However, there are other creative outcomes, many of which are also being considered by edX and all its partner universities. Although edX is a not-for-profit, there is a desire to make it self-sustaining. There may therefore be a fee associated with some of these other outcomes. We will not discuss them here because they are decisions for edX, its partners, and its board to make.

Certificates

As with many MOOC providers, certificates are routinely given at the completion of an edX class today. The question of academic honesty is being addressed in a number of ways, ranging from physically proctored exams to electronic proctoring. While MIT does not currently offer credit for certificates received on the edX platform, several institutions have started to do so. An alternative to certificates is badging, in which students receive badges for more granular achievements such as finishing a problem set. This gamification of the class results in goal-seeking behavior that may be more effective at promoting perseverance.[40] A modest experiment with badges was conducted as a part of the ChicagoX program. Badges also have implications for aggregating competencies. Competencies were discussed in the report of Working Group 1, and we will discuss aggregation later in this section.

Sequence Certificates

If a course earns a certificate, can there be a certificate for a sequence of courses? President Reif hinted at this in his inaugural address. Sequences can be thought of as "minors" that offer greater depth in a field than a single class. At the time of writing, *MITx* has launched two sequence certificates.

A natural next question is whether this reasoning could lead to an online degree. Georgia Tech has announced an online degree in computer science with Udacity and AT&T.[41] Since the objective of this report is to list possibilities, we leave the question on the table for MIT.

MIT as an Outcome

An additional outcome for a student who does well in a class may be a semester at MIT, a transfer to MIT, or even admission to MIT. While this is not MIT policy, and may never be, it has already occurred informally. A few successful edX students have in fact already been admitted to MIT in part on the strengths of their edX performances. One of them, Battushig Myanganbayar of Mongolia, was mentored by an MIT alumnus in Ulan Bator.[42]

Several MIT faculty members have expressed concern about the potential negative consequences of this emerging possibility. Concerns stem from the fear that high school students, who are already under pressure to overachieve to get into a good college, will now implicitly be expected to excel in MOOCs as well. On the other hand, online courses may be a "sensor" enabling MIT to detect talent and merit among students before they apply to MIT. Taking *MITx* classes may inform students of the great benefits of attending MIT, thereby greatly increasing the talent pool MIT draws from. This form of outreach may also help MIT reach minority populations. MIT may be able to approach luminaries from different communities who, by publicly taking or promoting an MIT class, may be able to encourage young people to consider an engineering education—preferably at MIT.

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40. Goligoski, Emily. "Motivating the learner: Mozilla's open badges program," *Access to Knowledge: A Course Journal*, Vol. 4, No. 1, 2012.

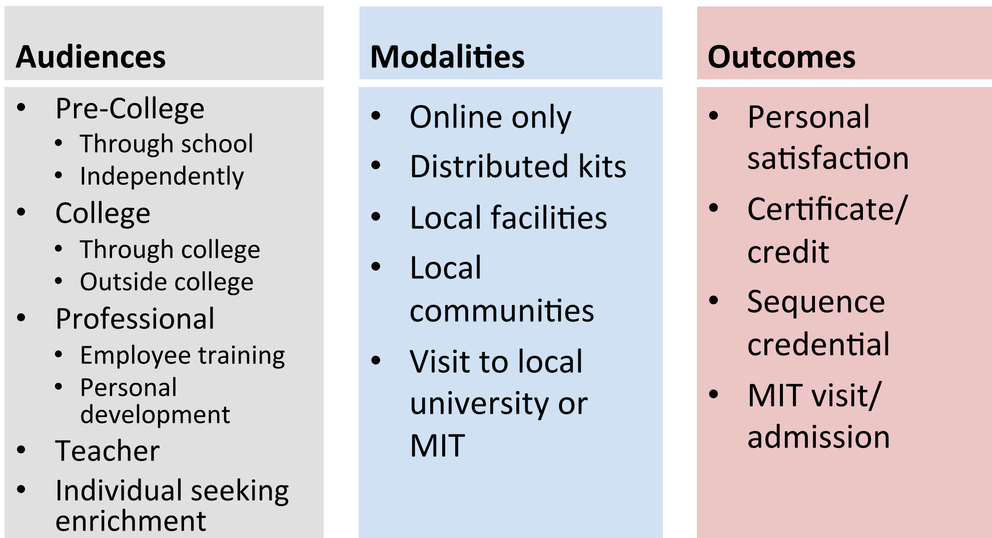
41. Lewin, Tamar. "Master's degree is new frontier of study online, *New York Times*, August 17, 2013.

42. Pappano, Laura. "The boy genius of Ulan Bator," *New York Times*, September 13, 2013.

Combining the Possibilities

We believe that many of the new opportunities in the global realm will come from combinations of the three categories: (a) addressing different audiences, (b) with different modalities, and (c) considering different outcomes. We show this in Figure 8.

Figure 8. The range of options for *MITx* classes

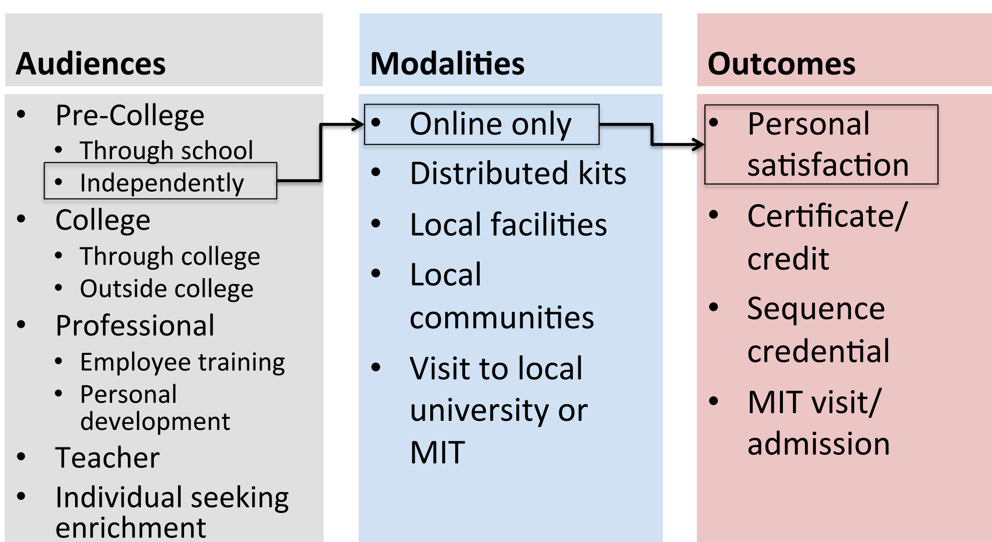


This framework enumerates several opportunities for *MITx*. We examine some scenarios below.

High School Student Takes a Class for Personal Edification

A student attending high school in Pennsylvania takes 6.00x, Introduction to Computer Science and Programming, outside her school. She does this entirely for her personal edification. This is the basic case shown in Figure 8a.

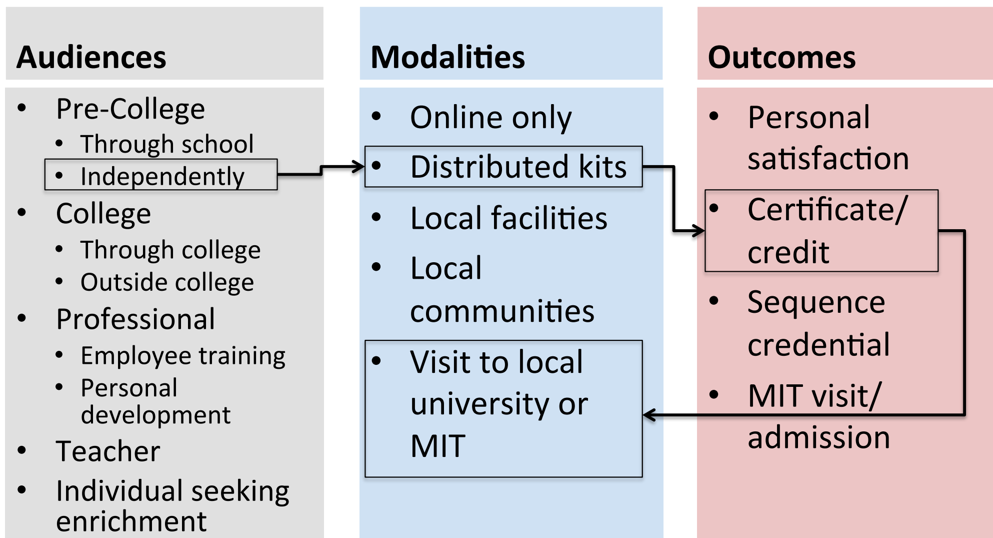
Figure 8a. Student takes a class for personal edification



High School Student Visits MIT for One-Week Summer Camp

A student at high school takes a robotics class, gets a certificate, and requests credit at her school. The class involves distributed kits for programming robots. She does very well, and she also visits MIT for a three-week summer camp for an intensive session on programming video games. This is shown in Figure 8b. Many examples exist of this summer activity approach, including Johns Hopkins University's Center for Talented Youth.[43]

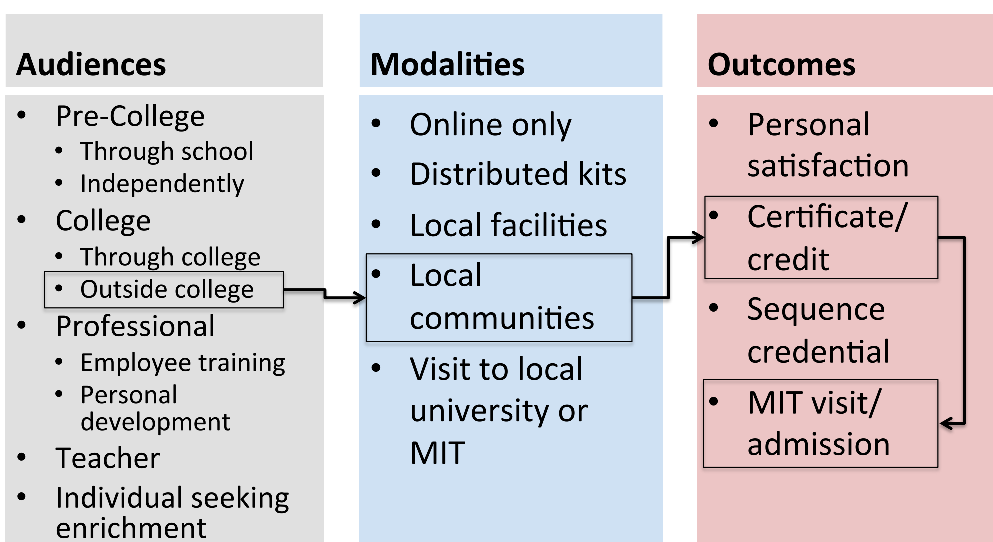
Figure 8b. High school student attends a summer camp at MIT



College Student Takes MITx *Class, Excels, Transfers to MIT*

A student at the Indian Institute of Technology, Campus X, takes 2.01x, Elements of Structures. In taking the class, she engages with a local community of learners mentored by an IIT professor who happens to be an MIT alumnus. She receives credit and subsequently works on a project with her professor that is of interest to a colleague at MIT. Armed with her excellent grades, her project, and her 2.01x performance, she applies for transfer to MIT. She is accepted, and she continues her education at MIT. This trajectory is shown in Figure 8c.

Figure 8c. Student excels, transfers to MIT

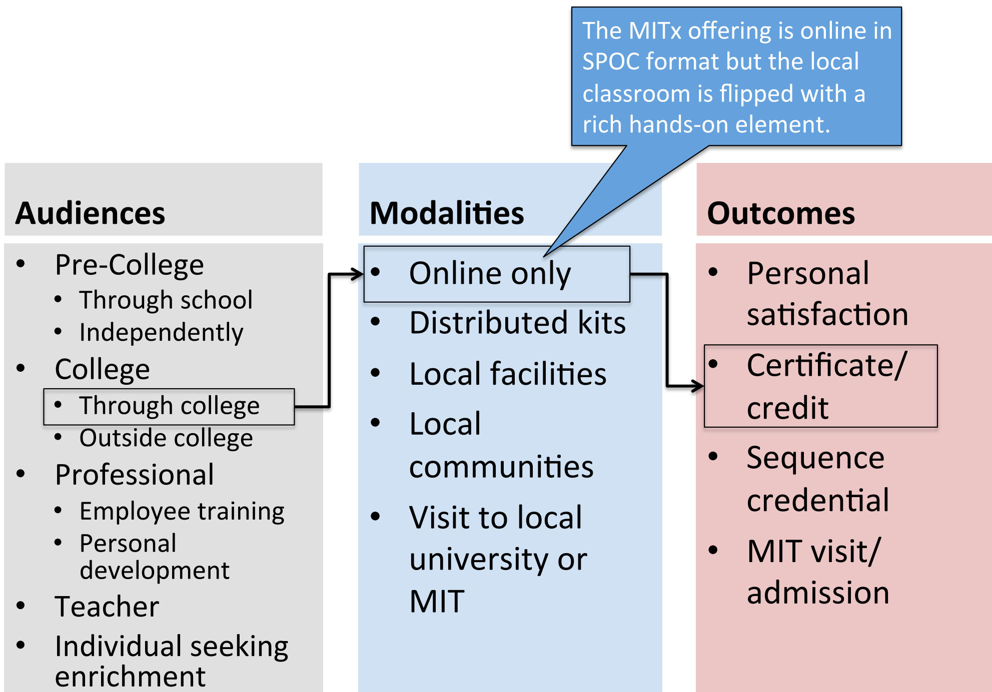


43. http://cty.jhu.edu/.

College Student Takes MITx *Class Through License at Her Institution*

A university in Brazil licenses 8.02x, Electricity and Magnetism, and delivers it to its students as a small private online course (SPOC). A student takes the class while embedded in the university. The university gives the student a grade in the class. The class itself is taught in blended format, because this university, which is new, is modeled on this cutting-edge pedagogy. This is shown in Figure 8d.

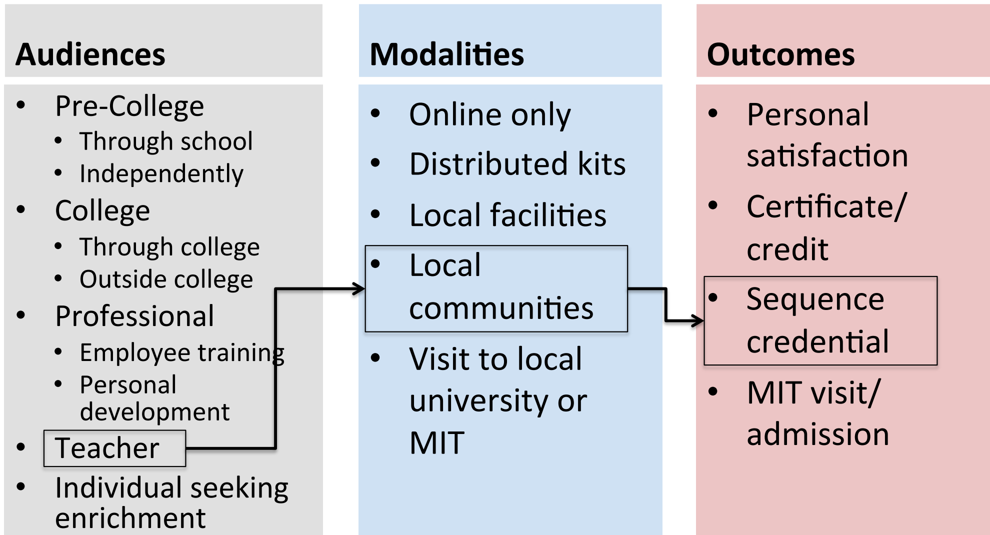
Figure 8d. Student takes a class in SPOC form while embedded in institution



A Teacher Takes a Class to Enable Him to Innovate in His Classroom

A professor at the same university in Brazil wishes to flip his classroom in physics. He seeks to understand best practices, as well as credibility, to persuade the university to support his experiment. He takes 8.MRev, developed by Professor Dave Pritchard and his team, to explore other ways to teach the material. He works with a local community of professors and passes the course, receiving a certificate. He also takes the underlying classes, 8.01x and 8.02x, and seeks a sequence certificate that MIT offers titled "Physics Teaching Series." This is shown in Figure 8e.

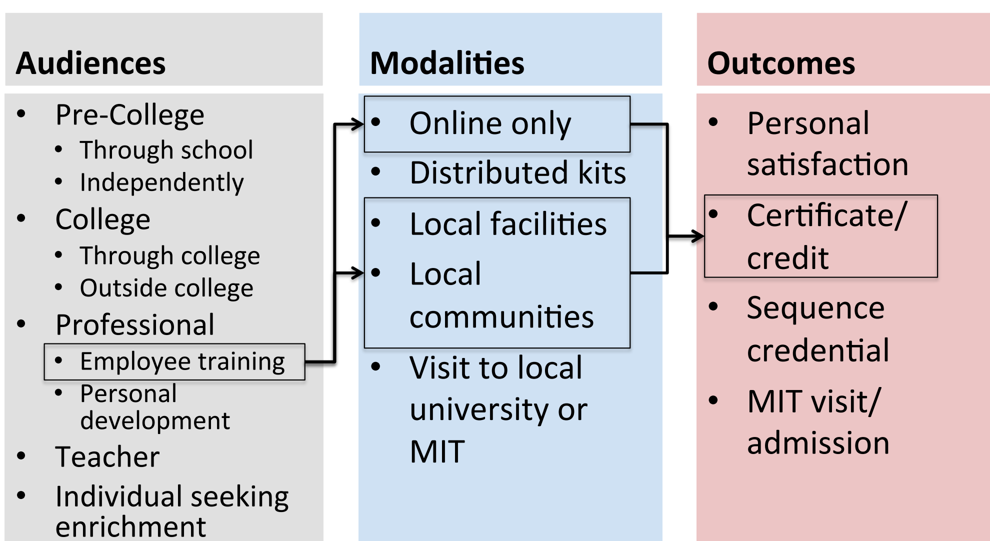
Figure 8e. Teacher takes a course sequence, gets a sequence certificate



A Professional at a Company Takes a Continuing Education Class Through the Company

Engineers at a medium-sized enterprise take a design and manufacturing class with the sponsorship of the company. They form a local community and are mentored by local MIT alumni. They also access a local fabrication facility so that they can make parts and receive hands-on experience. Leaders in the company sponsor this class because they want their engineers to become experts in manufacturing so that they can bring it in-house. This is shown in Figure 8f.

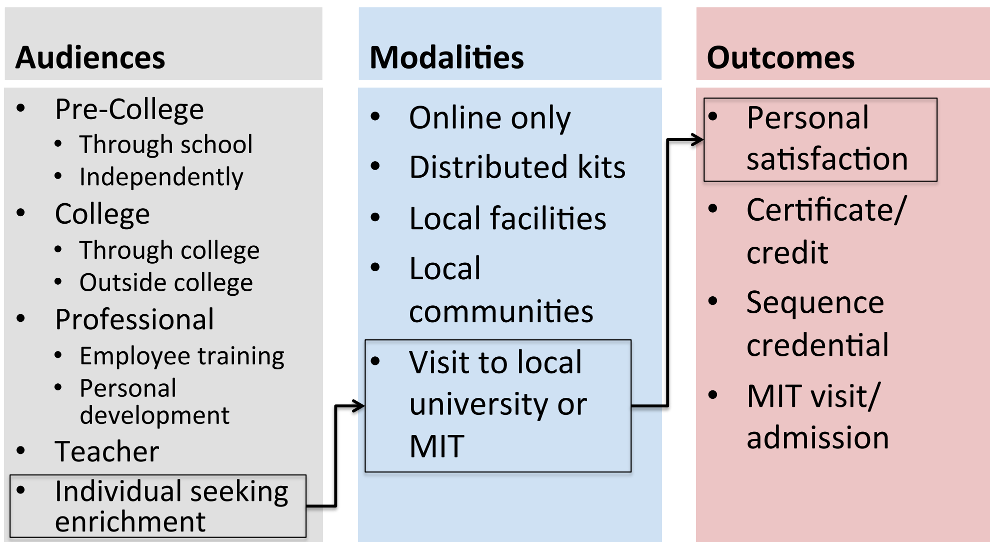
Figure 8f. Professional takes a class while embedded in a company



Retiree Seeks to Learn About the Aerospace Industry Before Visiting the Smithsonian Museum

A retired engineer becomes interested in the aerospace industry. He takes an *MITx* class on the history of the industry, perhaps created by Professor David Mindell, before taking his grandson to the Smithsonian Air and Space Museum for his birthday. He does this entirely out of an interest in personal enrichment. This is shown in Figure 8g.

Figure 8g. Retiree takes an *MITx* class



Other Scenarios

We have developed a framework for looking at different scenarios, as well as enumerated a number of them. There are other activities that MIT could pursue for engaging the world. The concept of an online degree is also one that must be listed for intellectual completeness. Current MIT regulations require at least a semester of residency, but we must consider, even if we reject it, the option of changing that rule.

MOOC.org + OCW = Customized Build-Your-Own MOOC

MITx is not the only international access project at MIT. Another such project, mentioned previously in this report, is OCW. The interplay between *MITx* and OCW creates several opportunities. Although OCW and *MITx*/edX both use the word “open,” they mean different things. “Open” in OCW indicates education resources that may be distributed using a Creative Commons attribution-noncommercial-share alike license. Anyone may download the material and reuse it according to that license. EdX, on the other hand, uses “open” to mean freely accessible web-based classes. A MOOC may not make its videos, for example, downloadable for reuse, and OCW does not offer a course that may yield a certificate. These two independent functions, though, may eventually converge. OCW materials may, in the medium term, become the building blocks for anyone in the world who wishes to build a customized MOOC. A university could “mash up” material from OCW with its own material, significantly reducing the cost of producing a MOOC for any university. A university in Brazil, for example, could combine OCW’s “Technology in Transportation” and “Internal Combustion Engines” with material on ethanol engines to create a course that is uniquely localized.

The announcement of MOOC.org by edX and Google makes this possibility especially real.[44] MOOC.org, supported by Google and powered by the edX platform, enables any user to upload a course for world consumption. This enables a democratization of MOOCs at a grand scale.

IMPACT UPON MIT OF ENGAGEMENT WITH THE WORLD

EdX's global reach can significantly enhance teaching, learning, and research opportunities for the MIT community. The audience that edX touches has the potential to better position the MIT community to solve the world's greatest problems in large part by deepening understanding of global challenges in a broad cultural, socioeconomic, and political context. Through edX, the MIT academic community will gain exposure to unique instrumentation, methodologies, expertise, and perspectives that otherwise would remain inaccessible, and learn from different academic, pedagogical, and scientific styles.

Opportunities for MIT Students

Over the years MIT has developed a robust infrastructure for students to engage with the global community; edX has the potential to build on these programs and initiatives in profound and interesting ways.

Internships and Learning

EdX has grown the classroom from several hundred seats to several hundred thousand. With increased potential for global academic study come new opportunities for real-world learning and interaction. More than ever before, MIT's student body comes from all corners of the world. This demographic shift means that we are educating students who have a great interest in combining a world-class MIT education with a meaningful and productive international academic experience. EdX presents great opportunities to place MIT students around the world to interact with the global community of *MITx* learners and innovators.

"Going further, students on international exchange or a co-op placement might still be able to participate in an MIT on-campus course during the time they are away," wrote Dean Daniel Hastings, Professor Hal Abelson, and Dr. Vijay Kumar in a 2011 report. "Similarly, we could accommodate intense *on*-campus experiences, such as letting students spend a couple of weeks in an immersive UROP project and make up for the missed work later."[45]

In the section of this report titled "Impact of *MITx* and edX on the World," we describe opportunities for MIT students to serve as ambassadors by visiting different learning communities around the world. Clearly, this kind of initiative has benefits for the global community, but the benefits for the students themselves are perhaps even more significant. Students can gain real-world teaching experience, working in multinational teams and communicating across cultural and linguistic boundaries. Operating in such an environment

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44. Fowler, Geoffrey A. "EdX, Google to create new online education site," *Wall Street Journal Tech*, September 10, 2013.

45. Hastings, Daniel, Hal Abelson, and Vijay Kumar. "Technology enabled transformation in the MIT learning experience," MIT Faculty Newsletter, Vol. 23, No. 5, 2011, http://web.mit.edu/fnl/volume/235/

imbues students with self-confidence and team-building skills and exposes them to different pedagogical opportunities and challenges. The notion of *MITx* ambassadors also presents new opportunities for personal and professional development, expanding a student's global network and career opportunities.

As noted previously, during summer 2013, MISTI placed 10 MIT students trained on the edX platform in four countries during their internships. These students' experiences should provide invaluable insight into the feasibility of more closely tying edX with MISTI, one of MIT's outstanding international programs, to create an initiative we might call "MISTIx." MISTI is already an extremely popular and successful program that provides students with real-world experience in corporations, universities, and research institutes around the world. By connecting these experiences to *MITx*, not only would the global *MITx* community benefit, but MIT students would also have the opportunity to develop their teaching, research, problem-solving, and language skills. With greater exposure to a global student population, MIT students would develop a more meaningful connection with the world, improving their skillset and gaining a deeper understanding of the challenges that most keenly need MIT's attention.

In addition to MISTI, a number of academic departments offer international internship programs. EECS, for instance, encourages students to take advantage of growing opportunities for incorporating an international internship experience into their EECS education. Through initiatives like the department's 6-A International Program, students are positioned to conduct research with learners and instructors around the world. *MITx* has the potential to build on programs like 6-A to incorporate real-world international engagement into the requirements of an *MITx* class.

The "infinite classroom" idea of D-Lab, where students can blend technology with international development, and the Sloan Action Learning Labs, which translate classroom knowledge and theory into practical solutions for real organizations across the globe, both have elements that could be enhanced by the vast potential of edX.

Student Teaching

Teaching assistants are an integral component of the on-campus classroom experience, providing invaluable support to instructors and students alike. As the classroom goes global, TAs continue to add value, but the benefits they reap increase as well. We might think of TAs in this new setting as "*MITx* TAs" or "*MITx* Global TAs." These students would serve as teachers in global communities for *MITx* while gaining real-world experience. We envision students working in this capacity to facilitate meet-ups at remote instructional sites or partner universities.

Student Research

MIT has a successful International Research Opportunities Program (IROP) that places undergraduate students in faculty-mentored research settings around the world. IROP experiences help students enhance their communication and leadership skills and refine their collaborative and decision-making capabilities while increasing understanding and awareness of global challenges. Through on-the-ground international research opportunities, a student might be able to conduct firsthand analysis and investigate solutions to a problem being discussed in an *MITx* class.

The writers of *Mens et Manus et Mundus* (2009) of the MIT Global Council envisioned a new initiative they called the Global Scholars Program; though the program has not yet been developed, its potential is even greater in an increasingly digital world. As the Council articulated its vision, a student would have the opportunity to "identify a country or region to study in depth and in person from the start of their time at the Institute. The student, working with his or her advisor, would then identify six classes in humanities, arts, and social sciences that focus on the country; they would be encouraged but not required to take the relevant language classes as well." The Council also suggested that students would attend monthly dinners with students and faculty interested in that region. Again, there are opportunities to integrate a Global Scholars Program into the global learning potential of edX.

Executive Education

While an MIT student is typically thought of as preprofessional, the Sloan School's executive education programs create opportunities for MIT to reach students who are established in their careers and are eager to gain knowledge that will improve their effectiveness on the job. Sloan's part-time professional master's programs (such as the Executive MBA and System Design and Management programs) educate students who are already employed. Instructors in these classes give assignments that are directly connected to students' professional responsibilities. With distance education, instructors can build on the success of these programs with students from far away and in interesting settings.

While we view all of these international opportunities as worthy of examination and analysis, it grappled with two philosophical questions that will need further attention:

- How do we free up time for students to carry out more activities abroad (field work, research, internships, semester abroad) while staying connected and engaged in MIT's curricula?
- If *MITx*, combined with a meaningful international experience, compresses an MIT education into a three-year undergraduate degree program, will our students be fully prepared to go out into the real world or on to graduate school? Three years is likely insufficient for the maturation one typically experiences during college.

Opportunities for MIT Faculty

Teaching

With a global audience at an instructor's fingertips, one might imagine the world as a laboratory in which MIT faculty can experiment with new teaching methods and collect data to inform and improve on-campus education.

Perhaps the greatest benefit of edX for an MIT instructor is the immediate feedback he or she receives about which methods are effective in a class, and which ones aren't. As the residential classroom is transformed, a faculty member can incorporate these lessons into the MIT campus teaching model to teach students more effectively. Whereas an instructor has traditionally had to wait until the end of a semester to collect student feedback, and from only relatively few participants, the analytics built into edX allow one to immediately gauge student learning and to constantly assess and adjust.

As MIT faculty develop new teaching partnerships with instructors around the world, it will be essential to devise some common infrastructure to ensure cohesiveness and effective collaboration. We recommend establishing a platform for interactive sharing between faculty of best practices and effective resources for distance teaching and learning. Collaborative distance teaching and learning inherently imposes different technology constraints than local residential teaching and learning, but it offers the opportunity for considerably more interaction and collaboration than the structure of MOOCs provides. For this reason, a common platform will be invaluable.

Finally, no longer will content delivery occur in one direction, from teacher to student. Similar to Wikipedia, which relies on the community to provide content, edX creates new opportunities for crowdsourcing or community-sourcing, allowing students to answer questions and collaborate in new and interesting ways. Relying on thousands of creative minds to provide innovative solutions will be invaluable to educators, and students will gain real-world exposure to enhance the learning experience. This will be a new form of crowdsourced teaching. Material could be made for free—by an intellectual commons not unlike Wikipedia.

Research

The increased exposure edX will provide for research is equally compelling. MIT faculty research will benefit from more in-depth interaction with society at large, positioning faculty to be more effective in identifying research opportunities with a real-world application. There will also be greater exposure to different perspectives with first-class researchers from around the globe, creating new and exciting opportunities for collaboration.

DISAGGREGATION: UNBUNDLING OF THE TRADITIONAL INSTITUTION

Central to a well-rounded and high-quality education are the synergies that develop across concepts, courses, and disciplines. That is, an education is greater than the sum of its parts. Residential universities perform many functions in the education of a student, ranging from coursework to sports, and from labs to social activities. Digital and online technologies could enable these functions to be unbundled. We explore the consequences of disaggregation in this section. Consider a university curriculum, for example. EdX represents an unbundling of the curriculum into individual courses. However, the unbundling can be much more extensive. Courses can be unbundled into modules, which we describe in the section titled “Modularity.”

In 2011–2012 the MIT Council on Educational Technology (MITCET) conducted three experiments that can be used to inform modularity in MOOCs. The focus of the experiments was to better understand the role of the Internet in providing learning experiences that are flexible in time and geography. The Council envisioned modularity as creating opportunities to personalize the educational experience through flexible majors and alternative or adaptive learning models. Briefly, the experiments were as follows:

1. In spring 2012, faculty oriented two aero/astro courses (16.20 Structural Mechanics and 16.90 Computational Methods for Aerospace Engineering) around mini-lectures, focusing on topics that proved to be challenging to students, and collaborative sessions in which students worked on problems or programming assignments together. Students were expected to review course notes before attending class, and were given the option of attending class remotely.
2. In 2012, 2.002 Mechanics and Materials II was offered concurrently to both remote and residential students. Course materials were modularized into an introductory core and four major components (plasticity, viscoelasticity, fracture and fatigue, and rubber). After completing the core module, students were able to study the remaining components in any order.
3. The Chemistry Bridge project developed self-paced modules to assist mastery of key concepts outside the classroom setting. Students visited the Chemistry Bridge website to take a pretest to assess their understanding of the subtopics that constitute a core concept. Upon submitting their responses, students were presented with a learning pathway—a curated set of websites, videos, and simulations selected to address the student's learning goals. After completing the steps in the pathway, students took a post-test to assess how well they understood the concept.

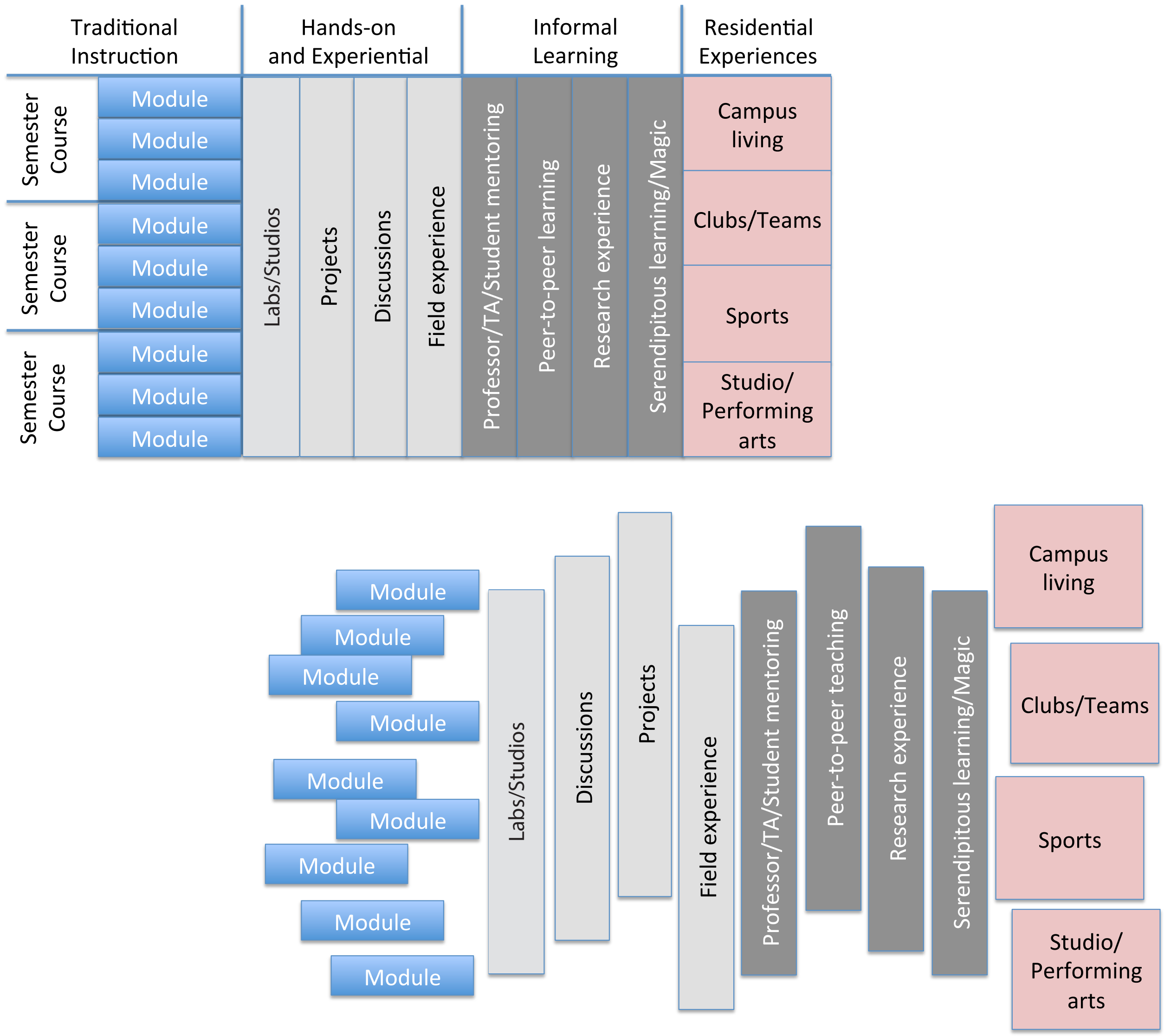
In the MOOC world, 80-minute lectures themselves have already been unbundled into 10-to-15-minute vignettes. All of this is enabled uniquely by digital learning technologies. The logistics of 10-minute lectures on a residential campus would be infeasible—the setup time and the time to walk between classrooms would be too great. Similarly, it is difficult to take classes from different universities. While students at MIT and Harvard do cross-register, the logistics of travel from one campus to another limit the extent to which this is practical. Online makes it possible for students to take classes from across universities more conveniently. We examine disaggregation here, starting with modularity.

Distributed Education

Each line in Figure 9 represents a possible parting line for the university. Universities and colleges in the United Kingdom and elsewhere have historically straddled different lines of the figure. In most university-college systems, universities maintain the degree program and credentialing. Unified university exams provide a standard assessment across the system. Colleges, on the other hand, can provide different combinations of services. In some situations, colleges are merely residential establishments. Often colleges provide tutoring, and in some cases they may also provide lectures and teaching of the content. Colleges can specialize along disciplinary lines. Sports and clubs may be either college-wide or university-wide. In most such systems, colleges are located in proximity to the university.

An institution such as MIT can thus be seen as an aggregation of functions that have not always been together. Disaggregation therefore is not necessarily a new phenomenon, but one that becomes more relevant with online technologies.

Figure 9. Unbundling of education



Distributed U

Online education will enable new models of distributed universities. MIT might consider creating affiliated campuses around the world, with students in different campuses sharing online content and forums. There is a growing trend of satellite campuses belonging to major U.S. universities. For example, Carnegie Mellon University has a campus in California, and Cornell University is establishing a campus in New York City. Meanwhile, Yale University has established a campus in Singapore, New York University has established a Shanghai campus, and Georgia Tech has one campus in Metz, France, and is opening another in Shenzhen, China. INSEAD has campuses in Fontainebleau, Abu Dhabi, and Singapore.

Today, because satellite campuses require traditional lectures, standards and offerings can vary across campuses. Online education and blended learning will enable more uniform teaching in satellite campuses. This idea mirrors the earlier "Global Tech" idea mooted at MIT during the creation of OCW.

Flipped University

An unaffiliated university could also base itself on cutting-edge online content. Students at the campus could use SPOCs but receive the hands-on education, discussions, informal curriculum, and residential experiences at their local institution. We refer to this as a "flipped university." New universities may use this approach to significantly enhance the university experience for their students, focusing on labs, mentorship, projects, and personal development. The online instruction in this case would be used just as MIT might use the material to flip its classroom.

MIT's long history in international programs enables it to lead this movement. The aggregation of content development will enable best-in-class, up-to-date pedagogical tools that can also be continuously improved using aggregated data.

Disaggregated Credentials

We have already discussed the disaggregation of the degree into smaller credential units such as course credentials, sequence credentials, and even badges. It is also conceivable that the credentialing entity may be different from the institution that offers the course. For example, a company could license SPOCs on several different topics from *MITx*, and offer its own credential to students who take a certain selection of classes. Over time it is not inconceivable that virtual universities will form that offer themed credentials by buying and reselling content from other players.

Modularity: Fragmentation of Coursework

A module is a unit of learning smaller than a full course. The notion of online learning units is appealing for many reasons. Learners are more likely to complete an online course if it can be taken in increments rather than as a full course, making modular learning more accessible to a wide audience. Modules are helpful for learners looking for specific conceptual or technical information, or for teachers looking for material with which to build or augment a course. In theory, customized or interdisciplinary courses can be put together from modules. Thus, a module repository would be a valuable resource for teachers and learners alike. Modules are cheaper to produce than full courses, and easier to update than a full course. We define "smooth modules" as standalone units, and "sticky modules" as those designed to be part of a course.

Modules can be put together "vertically," i.e., in obligatory order to make a course or module sequence, or "horizontally," where any order is acceptable to make up the course. Over the next three years, we suggest an action plan that includes the goals to: identify any new or existing *MITx* course that could be produced as modules; produce the "sticky" modules associated with these subjects; define a limited set of standalone ("smooth") modules and produce these; put in place a well-organized repository of existing and new modules and define guidelines for building and credentialing customized courses. The outcomes of this effort will increase accessibility of MIT course material. The audience includes residential MIT students and those away from campus, student and professional learners across the world, and teachers at many levels.

Introduction

For some time, it has been feasible to look up anything online and almost instantly obtain access to a short video explaining the query. Many of these videos are a minute or less in duration, some are longer, and many are very helpful. The notion of "modules" or self-contained learning units is thus pervasive and useful.

Traditionally, MIT subjects have been taught as a single course, encompassing a semester and many lectures. However, within a subject, one or a few lectures often encompass a specific topic. Thus many subjects can, in theory, be broken into units (modules) that could be studied separately. Multiple modules could be strung together in a defined or random order to construct a course. As we will discuss, deconstruction of courses into units can have interesting and useful outcomes.

Learning in units or modules could impact how a subject is studied through *MITx* or edX. We have concluded that the modular approach will make MIT-level subjects more accessible to many learners. The approaches we describe will benefit MIT students, on campus and off, and other learners across the world.

Setting the Framework with Some Definitions

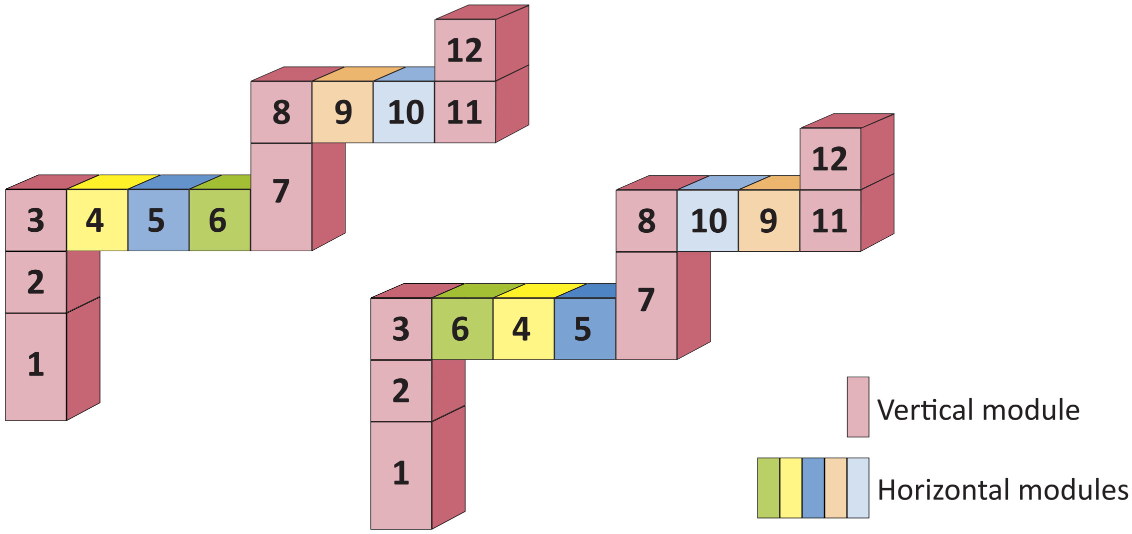
We define a module as a learning unit. The unit can be a single lecture, part of a lecture, several lectures, or a half-semester of perhaps 10 or more lectures. For example, the notion of ATP as an energy source in the cell could be discussed at an introductory level in a 15-minute module, but the broader subject of biochemistry would require several lectures to convey even an introductory understanding.

Modules change our idea of what a course is. A course can be deconstructed into modules, or constructed from modules. For some courses or for part of a course, the order of learning modules is important, and we define "vertical" modules as those that need to be studied in a particular and invariant order, such that material learned in module 1 facilitates the learning in module 2, and so on. A sequence of vertical units could form a larger "module sequence." For example, a vertical module sequence would place biochemistry after a module concerning principles of organic chemistry, and before a module about metabolism. In contrast, for some courses, modules can be studied in any order, and we term these "horizontal" modules. In practice, most courses are likely to comprise a mix of sequential vertical units and horizontal material (see Figure 10).

We define "sticky" modules as those that are designed to be linked to form a course, and that usually contain some indication that the modules are part of a course. For vertical modules, this would include reference to previous modules and indication of how the preceding material fits into the topic of the specific current module. For horizontal modules, this could include references to the overall learning goals of the course.

A related designation is the notion of "smooth" modules to indicate standalone learning units that are not necessarily part of a course and that would not contain references to course goals or preceding or subsequent modules. A smooth module should present its own preamble, and the

Figure 10. Modules in different orders



learner should emerge with a clear increment of learning. Sticky modules can form the basis for smooth modules, and vice versa.

Deconstructing a subject into modules would be a top-down approach. A bottom-up approach would build modules without a course in mind. It would be up to the learner or the teacher to determine how to use these. In each case, we would envision that a module would be associated with homework problems that would allow the student to evaluate the learning outcome.

What Is the Status of Modular Teaching at MIT, and What Lessons Are Emerging?

While the formal notion of modularity is not widespread at MIT, most subjects are organized in terms of learning units, and there has been an effort among certain departments (chemistry and mechanical engineering) to break up a subject into smaller units. This deconstruction may be associated with choices, letting a student decide to study only a fraction of the total topics offered. Many faculty consider it feasible to break their courses into modules.

Useful Outcomes

The useful outcomes of modularity fall into four overlapping categories.

Ease of Production and Updating

A clear advantage of modular units over full courses is that each unit can be produced independently, with clear positive outcomes. A unit thus takes less time and resources to produce, allowing units to be gathered more readily than full courses.

Modular organization makes it easy to include multiple faculty members in the teaching of a course. This lowers the barriers for teaching a course through *MITx*.

If a course is composed of modules, updating a unit is much simpler than having to update an entire course in which only part of the material has changed. This ease of updating is likely to be critical for keeping MOOCs "living," and addresses a major concern that online subjects will become static after the initial excitement of live lectures.

Accessibility of Learning

Incoming MIT students, especially at the graduate level, would use modules to get up to speed before entering a program. This would offer students of different educational backgrounds an opportunity to succeed optimally at MIT. Using modular units to help study for preliminary exams would also be a strong benefit. Similar considerations would apply to MIT postdocs and faculty seeking refreshers or explanations of unfamiliar topics. Modules can enable both conceptual and technical learning.

An MIT student away from campus could take a subject incrementally through *MITx* without disrupting commitments associated with an internship or break elsewhere.

Modularity is likely to increase the success of non-MIT learners as well. A course broken into modules that can be independently completed would allow students to work at their own pace, which could increase completion rates. Smaller increments of learning would also make MIT-level material more relevant to learners at the high school level or to those without relevant background to complete the entire course.

In all cases, a well-organized repository containing *MITx* and edX-derived modules will be essential.

Learning Innovation

Modules allow new teaching tools to be readily incorporated into a course, if only a module or two needs to be changed. Where multiple teachers are involved, each can bring their own teaching innovations and unique style to the subject.

Online modules offer a duration of teaching that the classroom cannot. In-class lectures must be of standard durations, but there is no barrier to producing a 20-minute digital module.

Modules can reduce redundancy of MIT subjects in a new way, where material in one department can be substituted for similar material in another department. There could be a common entry set of modules that present fundamentals, after which different subjects could diverge to focus on specific aspects of a field. For example, thermodynamics (20.110J / 5.601J / 2.772J) includes a common core of approximately one-third of the material taught at the start of the semester, after which the subject diverges into a continuation of a chemistry-based or bioengineering-based subject. This approach would be cost-effective, and it would benefit both residential and global learners.

Probably the most popular innovative notion of modules is that of do-it-yourself courses, where a student or teacher assembles a course from existing modules. This type of approach can also bring together material from one department or field. For non-MIT pre-college or college students, pertinent aspects of a subject could be included at the students' specific levels. For professionals, a personalized or customized course could focus on specific aspects of learning relevant to their fields.

Modules could also facilitate the teaching of interdisciplinary, interdepartmental, or inter-university super-subjects. For example, say that a faculty member wants to teach a course called Frontiers of Regenerative Biology that includes foundational material from his own course as well as material from three other MIT subjects in two different departments (involving at least three other faculty members) to incorporate multiple perspectives. The faculty member also invites faculty from another edX university who teach a specialized course on mammalian stem cell methods. The course is put together in modules, and it becomes the definitive course on regenerative biology. It can be easily updated to stay current with the rapidly evolving field, and new material or teachers can be added. Some of the modules also have the capacity to be standalone, and these are reformatted for this purpose. For learners who don't want to take the full course, a module sequence comprising about one-third of the course is suggested. Notably, this course could only exist online.

Tools for Teachers

Many useful teaching tools associated with modularity are also presented in the preceding section, "Learning Innovation."

Modules provide teachers with units of learning that can be incorporated into a subject taught in a classroom at MIT or elsewhere. Where a course is being taught at another institution, a modular organization allows a teacher to choose which material should be incorporated. This can accommodate both the level of the learners and the desired focus for the course.

The ability to access several modules with similar content but different teaching styles or example types allows teachers to present material in ways that suit different learning styles.

An important tool relates to teaching assistants at the graduate, undergraduate, or postdoctoral level. Organization of a complex course as modules can allow specialization and make teaching opportunities more accessible, as teaching stints could be shorter than a full semester.

Challenges

Modularity presents both pragmatic and conceptual challenges.

Conceptual Considerations

It will be necessary to identify which new *MITx* courses can be made modular, and which existing *MITx* courses could be reworked into a modular format. Which key courses should be tackled first? Which modules derived from courses are important enough to be reworked into a standalone or "smooth" format?

One key question is whether and how modules can be built into customized courses. Once an annotated module repository was established, there would be no barrier to a learner picking some modules and viewing them in sequence. However, more productive learning would include guidance as to what modules are likely to work together to give a specific learning outcome.

It might be preferable to answer questions of modularity before approval for a new *MITx* course is given. Guidance on possible departmental courses would come from faculty or instructors within a field or department. Interdepartmental or interdisciplinary material would require an interdisciplinary team. This organization would need to be streamlined.

Pragmatic Considerations

Modules need to be produced, and the mechanism by which existing *MITx* courses could be broken into modules needs to be addressed.

A well-organized module repository would be essential, including a system both to catalog and to allow ready access to material. The repository would need to indicate whether modules are standalone or part of a course. Intellectual property considerations with regard to using edX modules must be addressed.

Credentialing is not an issue if a single subject is produced as a modular course. However, for customized or personalized courses, credentialing might be done incrementally or in a customized fashion. However, it may not be possible to give credit for personalized courses due to staffing considerations.

Reaggregation

Disaggregation of functionality in other industries has been followed by reaggregation, often by other players. This may happen in education as well.

Student-Centric Reaggregation of Education Systems

Students may be able to aggregate the functions of a university around themselves by picking and choosing fragments from the new ecosystem of disaggregated education. A student could receive instruction online, register at a fab lab to receive training in manufacturing, attend a study group to discuss a philosophy class, commute to a university on weekends to use chemistry labs, and so on. In rural areas, science-lab buses could offer students access to the equipment they need on a periodic basis.[46] The content the student receives may itself be a mash-up of modules drawn from different providers to create localized flavor. There may be agents—virtual universities—that bundle such functionality together for students to make the experience more seamless. New players may emerge who offer aggregated credentials under an accreditation umbrella. Perhaps MIT could become a leader in this area.

Some versions of this idea have begun to find practical adoption. For example, Kepler, an education project in Kigali, Rwanda, uses the reaggregated model of education to create a low-cost, blended learning environment for local students.[47] Creative solutions of this type seem both inevitable and welcome. MIT can play a role in shaping such a future, especially in conjunction with projects such as D-Lab.

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46. Cardia, Alexandria. “Street smarts: the BioBus brings a rolling science lab to resource-strapped schools,” *Scientific American*, February 6, 2010.

47. O’Neil, Mega. “Rwandan degree program aims for a ‘university in a box’,” *Chronicle of Higher Education*, September 16, 2013.

MOOC.org + OCW = Reaggregated Content

The interplay between *MITx* and OCW creates several opportunities. First, although OCW and *MITx*/edX both use the word "open," they mean different things. "Open" in OCW indicates education resources that may be distributed using a Creative Commons attribution-noncommercial-share alike license. Anyone may download the material and reuse it according to that license. EdX, on the other hand, uses "open" to mean freely accessible web-based classes. A MOOC may not make its videos, for example, downloadable for reuse. Similarly, OCW does not offer a course that may yield a certificate. These two independent functions may eventually converge, however. OCW materials may, in the medium term, also become the building blocks for anyone wishing to build a customized MOOC. They may mash up material from OCW with their own material. This could significantly reduce the cost of producing a MOOC for any university. A university in Brazil, for example, could combine OCW's "Technology in Transportation" and "Internal Combustion Engines" with material on ethanol engines to create a course that is uniquely localized.

The announcement of MOOC.org by edX and Google makes this possibility especially real.[48] Supported by Google but powered by the edX platform, MOOC.org enables any user to upload a course for world consumption. This enables a democratization of online content at a grand scale.

BLURRING OF BOUNDARIES

The concept of learning "anywhere, at any time" gives rise to questions about the meaning of a campus—both in terms of location and in terms of time. Time, location, and people can be blended in a way that was infeasible in the past.

Time and Space Boundaries for MIT Students

The time boundaries of an MIT education today are sharp. A student's formal affiliation starts on the first day of classes and ends on graduation day. Online may change this paradigm, enabling more blurred statuses.

First, pre-college students may be able to take *MITx* classes from edX and get credit before they come to MIT. To date, MIT has been very hesitant to permit such a credit transfer, but we list the possibility here because the implications are significant. Students completing a number of credits before they come to MIT could decrease their time at MIT and therefore reduce the cost of their education.

Second, students today have limited opportunities to travel or work away from MIT during their tenure. Many students have summer internships, and a few take a semester off, but long breaks to get substantial experience or launch a startup are not ideal, for two reasons. First, long periods may complicate student-loan and financial-aid statuses. Second, students may "lose their edge" during long absences, forgetting the core concepts they need to graduate. Online education may be able to address both problems, offering more flexibility to students who wish

48. Fowler, Geoffrey A. "EdX, Google to create new online education site," *Wall Street Journal Tech*, September 10, 2013.

to follow more unconventional paths. Today's more brittle approach may well be incompatible with the emerging needs of MIT students, who have a much more dynamic palette of options from which to choose.[49] This idea was also anticipated in the creation of OCW, where it was called "Flex Tech."

Finally, it is conceivable that graduation from MIT could confer an ongoing online benefit—a lifelong membership to a font of continuous education. This idea was anticipated by the earlier study during the creation of OCW and called "Forever Tech."

Boundaries with Outside Partners

Both research and education at MIT have long had deep ties to the outside world—be it governments, various intellectual communities, or industry. One of the benefits of an MIT education is the rich variety of real-world case studies that MIT professors present to students. However, the mechanism for achieving this today is informal. MIT's vast network, which consists of MIT alumni, sponsors, members of the MIT Industrial Liaison Program, and personal contacts of MIT's faculty, can contribute to both education and research in a much more direct way using online education. They could do so by producing case studies that faculty can link, at their discretion, to regular curricula. Outside experts may also be able to leverage online technologies to regularly give presentations and lectures that provide a different perspective. Finally, this increased interaction with the outside world could also enable experts to come to MIT as executives or researchers in residence. This is not a new idea, but it could be much more closely integrated with teaching and mentorship.

The presence of a large cadre of outside experts will also enable MIT to create lifelong-learning content that is crafted specifically for outside partners. This idea is similar to the "tech-tech" idea presented in the OCW report.

Implications for an Innovation Hub

By blurring boundaries, changing the residential campus, and merging *MITx*/edX strategy with an overall strategic goal of being the global innovation leader in higher education, MIT can truly be the center of creativity and innovation. Picture the MIT community as we have described in this section: with alumni, students, researchers, professors, and industry influencing each other uniquely within the MIT ecosystem, we will have the ability to understand education and innovation with much greater resolution. International collaborators in such places as Singapore, United Arab Emirates, and Russia will want to participate regularly in this hive and glean from our latest understanding. Domestically, MIT will be the clear choice for national innovation and research policy, as the breadth and depth experienced and centralized in Cambridge will have no equivalent elsewhere.

With online education inducing a more innovative education and experience in Cambridge, a vibrant international hub can be created that gives international collaborators an opportunity to engage with the residential experience and participate in regular international innovation forums. MIT will be able to supply a unique experience that will only exist in Cambridge, even

49. Dembosky, April. "Dropouts look to learn from Zuckerberg," *Financial Times*, June 25, 2011.

though all supporting materials and publications will eventually be published internationally through edX courses and other online publications. MIT can therefore supply a new strategy for these partners: develop your own domestic MIT over time, by learning, training, and achieving desired performance through participation in the international hub. Each country's local MIT can thus ramp up appropriately as progress in training and innovation is made in Cambridge, resulting in an ecosystem in each country consisting of both MIT Cambridge and their local embryonic MIT. This idea echoes the earlier thoughts of a "Venture Tech" mooted during the creation of OCW.

Summary

The Working Group noted that while edX enables unprecedented outreach to the world, it also have several attendant impacts. First, the outreach to the world will also enable significant benefits to the campus. Second, online technologies have enabled various forms of unbundling and disaggregation in other industries—and academe must take advantage of such disruptions rather than ignoring them. Third, online access blurs the boundaries of the university because material can be accessed at any time from anywhere.

Access to the World

The group felt that since the opportunities in online access to a world population were likely to be rich and diverse, it would be more fruitful to develop a framework, which could capture the opportunities, rather than to enumerate them as special cases. To that end, the group looked at three categories of options: the global audiences of edX, the modes of online education and the possible outcomes. In global audiences, the group considered pre-college students, college students, working professionals outside educational institutions, teachers, and individuals seeking enrichment. Amongst these, we further distinguished students and professionals as either taking edX classes through their institutions or companies, or privately on their own. Amongst modes of online education, we listed not simply taking courses online, but also "extra" options such as enhancing the online experience with distributed experimental kits (such as LEGO® MINDSTORMS™), visiting educational universities on weekends for coaching or access to equipment, receiving mentorship from local experts such as MIT alumnae, and perhaps even visiting MIT or partner universities for intensive week-long or month-long immersions. Amongst the outcomes, we listed the satisfaction of personal enrichment, certificates, certificates for sequences of classes, degrees, awards of visits to MIT, and the opportunity to be admitted to MIT. We felt that permuting these options could reveal most of the possibilities of online education were likely to yield.

Impact of the World

The involvement of individuals from around the world will create a number of unique opportunities for MIT students and faculty. First, MIT students will be able to participate in teaching worldwide, be it as TAs in far-flung destinations or as the teachers running the courses from MIT. Second, MIT students could use the partnerships and reach engendered by *MITx* to engage in research and fieldwork at a scale that has been difficult to conceive in the past. Both of these opportunities will further enhance students' experiences by giving them global exposure and real-world experience. This is consistent with the emerging new theme for MIT: *mens et manus et mundi*. These opportunities will also extend to faculty, who will similarly be able to inform their teaching with global experience and feedback. Faculty will also be able to both communicate to and extend their research to encompass global audiences.

Disaggregation

The group noted that traditional institutions such as MIT offer a bundle of services such as courses, labs, studios, tutoring, a living community, clubs, teams, and sports. These services can be unbundled in the future. Students around the world can access instruction online unbundled from the other aspects of the Institute. Similarly, and perhaps more immediately, courses themselves can be unbundled into modules that will enable a great deal of flexibility and "portability" of material for both students and faculty. Unburdened by the logistical constraints of the in-class instruction, students can pull information rather having it delivered to them serially. Modularity will also promote flipped classrooms, as well as more fluid project-based and problem-based learning. Finally, modularity will make the development, maintenance, and reuse of online material more efficient.

Blurred Boundaries

Online tools enable learning anywhere at any time. This blurs the physical and temporal boundaries of the university. Students can take classes not just on campus, but while they are at companies doing internships, or before they "join" the institution, or after they graduate. In fact, "admissions" as we know it may be replaced by "membership" at MIT; alums, for example, can take classes through edX long after they graduate. Similarly, practicing alumni may be able to develop material for campus, and the research enterprise may become more commingled between corporations and universities, enabling a new innovation ecosystem.

Working Group 3

A New Financial Model for Education

Evaluate the future strength and sustainability of MIT's current financial model in this evolving context and propose alternative or complementary approaches.

—President L. Rafael Reif

THE NUMBERS BEHIND AN MIT EDUCATION[50]

MIT is a world-class institution where research and teaching are integrally connected, where hands-on learning and relevance to the world are key values, and where advancing knowledge and educating students is the overarching mission. Today, MIT educates just over 11,000 students.[51]

In 2013, MIT received over 43,000 student applications, and only 10% gained admission to their program of choice. Undergraduate applications topped 19,000, and only 8.2% were admitted. By contrast, *MITx* enrolled just over 300,000 unique students in the year beginning in spring 2012.

Presented with these statistics, we must stop to wonder:

- Can we advance the mission of MIT by educating more students?
- Can innovations in online learning improve access and affordability?
- What is the value of an MIT education, residential or online?
- How will the adoption of online learning, by MIT or others, impact the financial model of MIT?
- How has MIT's financial model evolved?
- Is the current model sustainable?

To begin to answer these questions, we examined a myriad of records and constructed a series of historical datasets related to finances, people, and space at MIT. With this historical perspective, we are increasing our understanding of how MIT's financial model has changed over time. We are evaluating how students finance their educations, articulating the outcomes of an MIT education, and developing approaches to modeling the scenarios that will emerge from the Task Force discussions. We have immersed ourselves in discussions and challenged assumptions and findings, and we are confident that the best approaches for continuing to enable MIT for future generations will emerge.

However, the focus of this preliminary report is on laying out the range of opportunities and possibilities that online learning, edX, and *MITx* offer MIT. The questions we are trying to answer are complex and nuanced, and further work is needed to provide appropriate and detailed answers. Debate and analysis will continue in the coming months leading up to the issuance of the final report of the Task Force, but we want to share preliminary observations at this early stage that put our conversations and work in context.

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50. Data provided by MIT's Office of Institutional Research and Admissions Office.

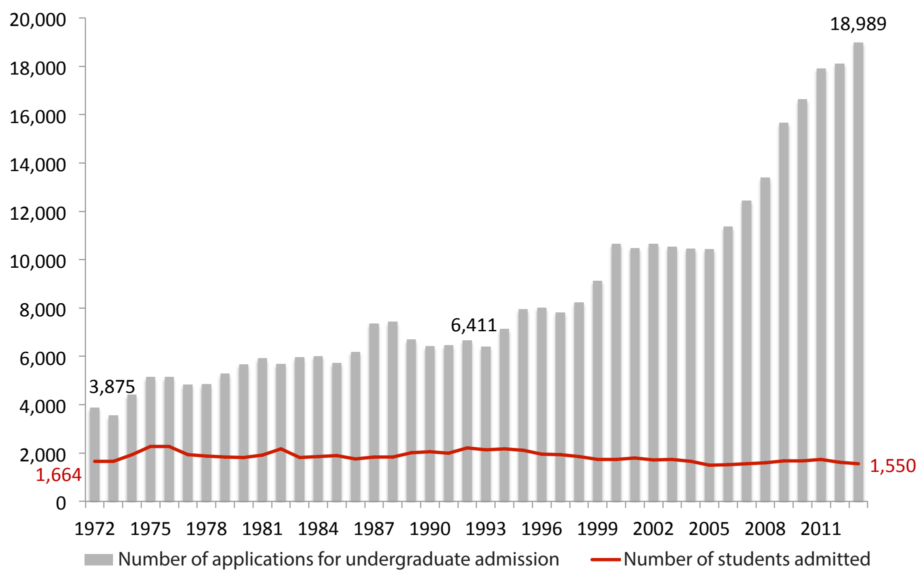
51. In 2013, MIT had 1,022 faculty, 4,503 undergraduates, and 6,686 graduate students. In addition, MIT had 789 instructional staff, 1,441 postdoctoral scholars, 1,173 research staff, 1,308 visitors (including 745 visiting students), and 4,549 other staff members (excluding affiliates).

INCREASED DESIRABILITY OF AN MIT EDUCATION

MIT graduates contribute to the world in extraordinary ways, but MIT is able to admit only a fraction of the exceptional students who wish to come to campus. Undergraduate selectivity has increased dramatically over the past 20 years among all of MIT's peer institutions. MIT has admitted students at a very low rate for many decades as applications for both undergraduates and graduate students have grown significantly.

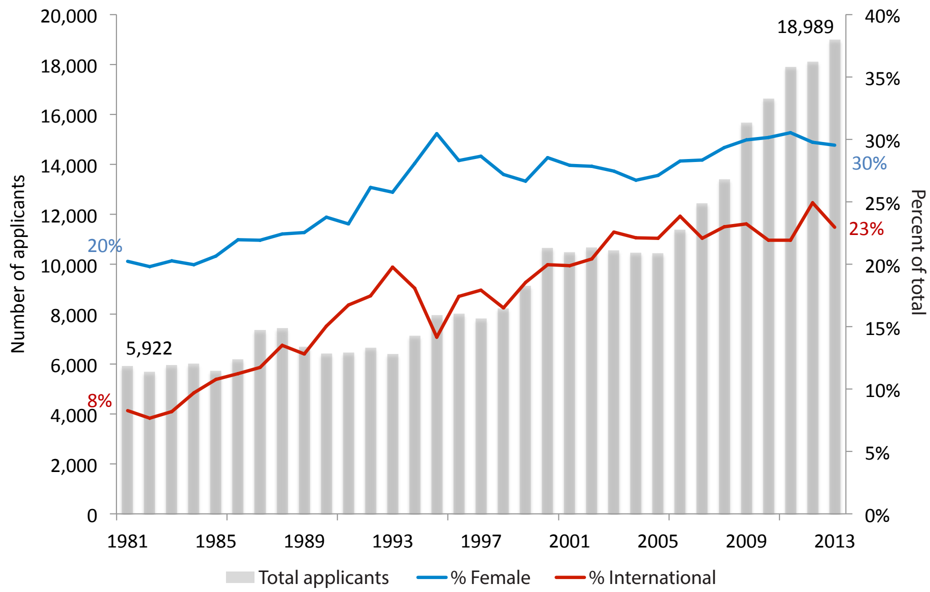
Undergraduate applications have tripled since the early 1990s to 19,000, while admissions have been relatively flat at 1,800–2,000 students (Figure 11). Admitted students have chosen to enroll at MIT in higher proportions. In the mid-1990s, one out of every two admitted students chose to come to MIT. Today, nearly three out of four students admitted to MIT will choose to enroll. The numbers of international and female applicants have grown as well, with internationals comprising close to 25% of applicants and women comprising about 30% (Figure 12). Applicant quality has also increased. The mean Math SAT score of today's applicant pool (737) matches the mean score of students who enrolled at MIT in the mid-1990s. Today's enrolling freshmen have the highest mean Math (769) and Verbal (723) SAT scores of any previous class.

Figure 11. Undergraduate applications and admissions, AY1972–AY2013



Source: MIT Admissions

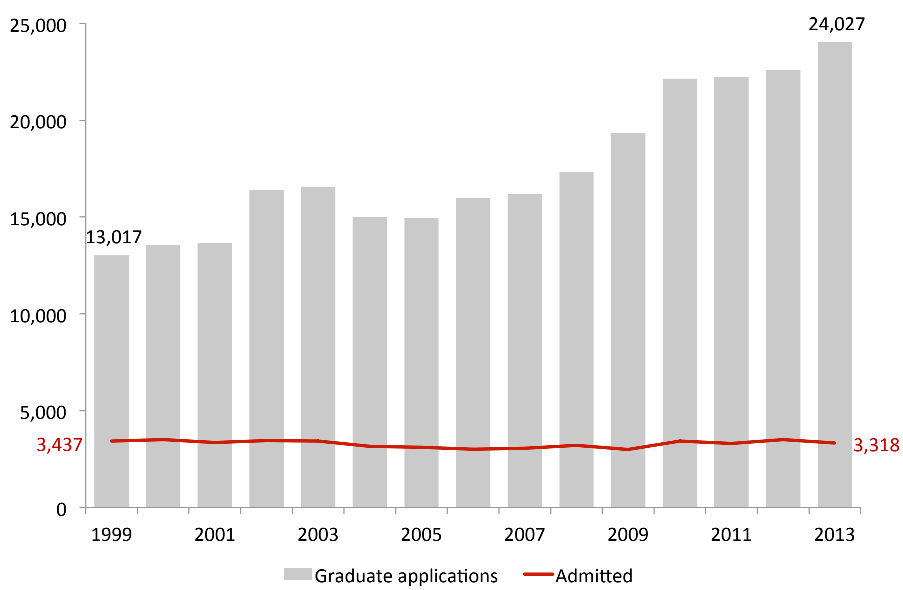
Figure 12. Undergraduate international and female applicants as a proportion of total applicants, AY1981–AY2013



Source: MIT Admissions

The pool of graduate applicants to MIT is increasingly deep as well. Graduate applications have almost doubled since the mid-1990s, to 24,000 in 2013 (Figure 13). During the same period selectivity has increased, with the percentage admitted reduced from 26% to 14% and yield increasing from 59% to 65%. There is a vast unmet need among well qualified students for access to high-quality education.

Figure 13. Graduate applications and admissions, AY1999–AY2013



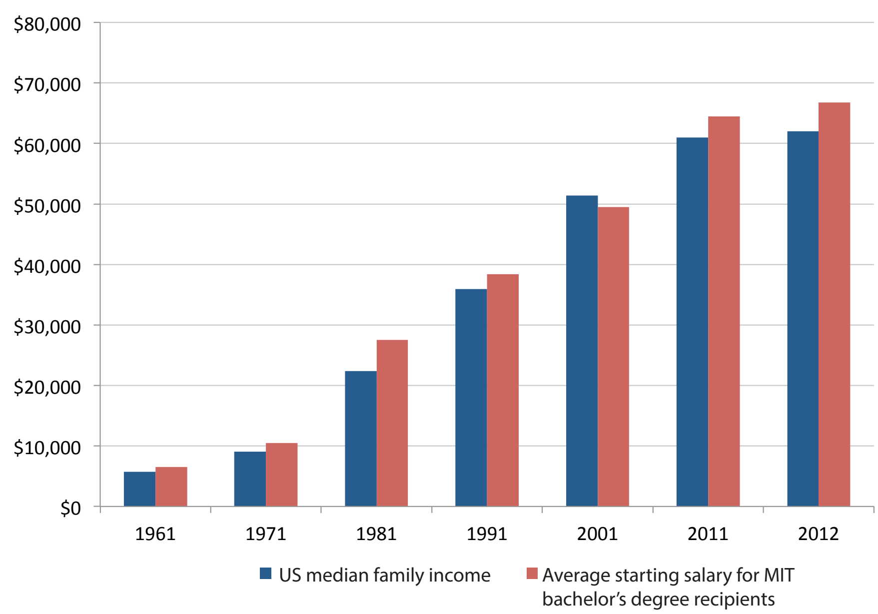
Source: MIT Institutional Research

THE GREAT VALUE OF AN MIT RESIDENTIAL EDUCATION

MIT has a significant impact on educating some of the brightest engineers, scientists, and businesspeople of our time, and graduates from MIT perform exceedingly well in their life pursuits. For instance:

- If trends continue, between 30% and 50% of graduates at all degree levels will form companies within 20 years of graduation, playing an important role in job creation.
- The average starting salary of an MIT undergraduate upon graduation ($66,800 in 2012) has been consistently higher than the U.S. median family income ($62,035 in 2012) (Figure 14).
- The undergraduate completion rate has been over 90% since 1992, with recent graduation rates of 93%.
- Doctoral student completion rates within eight years approach 80%.
- Eighty percent of MIT undergraduate alumni continue on to graduate school at some point in their lives (70% within five years of graduation).
- Twenty years after graduation, most MIT undergraduate alumni have reached a senior-level or higher position.
- Twenty years after receiving their MIT degree, most MIT alumni across all programs earn between $150,000 and $200,000 per year, excluding bonuses.
- About three-quarters of undergraduates and master's level graduates are employed by industry, while nearly half of doctoral alumni go into academia.
- MIT graduate alumni produce a significant number of patents and inventions, advancing the boundaries of science and engineering.

Figure 14. Average starting salary for MIT bachelor's degree recipients, 1961–2012



Source: MIT Global Education and Career Development

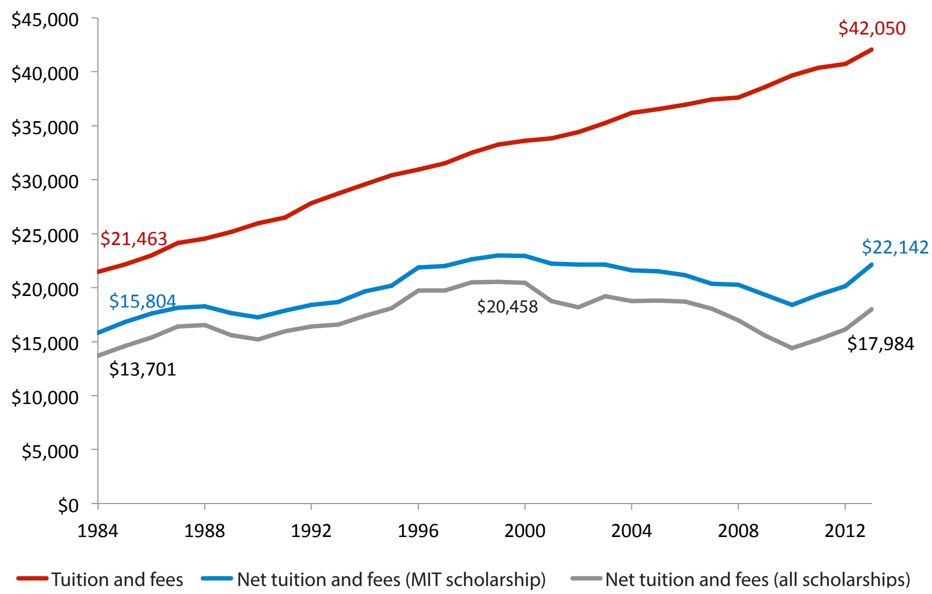
IMPROVED AFFORDABILITY OF AN MIT EDUCATION

The public conversation about escalating higher-education costs and their impact on access for students from all socioeconomic levels is ever present. Some see online learning as an opportunity to make education more affordable. While it is true that higher education is expensive, MIT remains committed to need-blind admissions and to meeting the full financial need of its undergraduates.

Nonetheless, the actual cost of educating an undergraduate student at MIT with the kinds of outcomes discussed above is twice the price of tuition charged by MIT. The Institute further discounts that sticker price through its need-based scholarship program. The average net tuition (defined as the sticker price minus MIT need-based scholarships) is a better metric of MIT's affordability, as well as a more accurate measure of MIT's financial investment in its undergraduates.

The gap between the price of the tuition and fees charged by MIT and the average net tuition and fees paid by students after receiving MIT scholarships demonstrates MIT's commitment to making an MIT education as affordable as possible for students coming from all socioeconomic backgrounds (Figure 15).

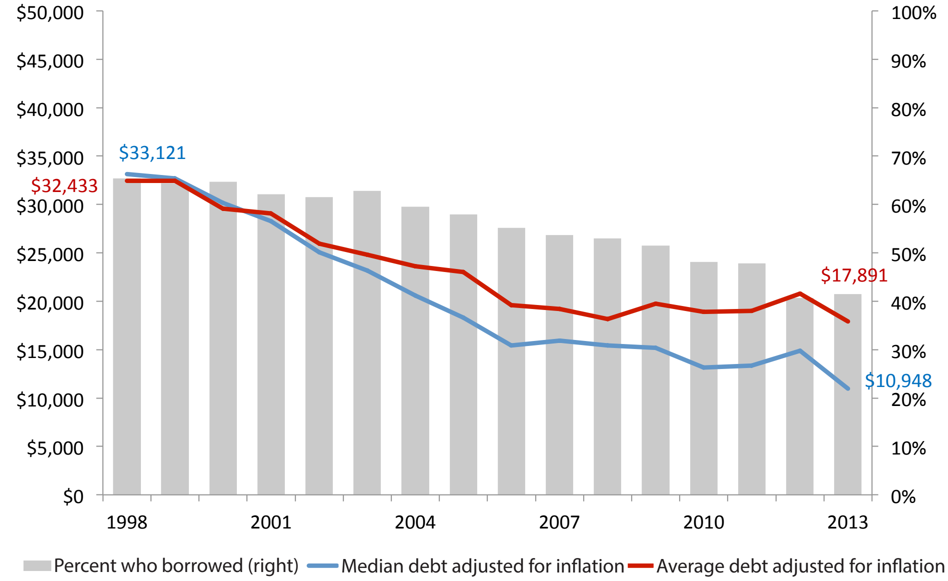
Figure 15. Net undergraduate tuition and fees, AY1984–AY2013 (inflation adjusted $2012)



Source: MIT Student Financial Services

Undergraduate debt has been dramatically reduced since the late 1990s. From 1998 to today, the percentage of undergraduates borrowing has decreased from 66% to 40%, while the mean borrowed amount has been reduced, from $33,000 to $11,000 (adjusting for inflation) (Figure 16).

Figure 16. Average undergraduate debt load at graduation, 1998 vs. 2013 (inflation adjusted $2012)

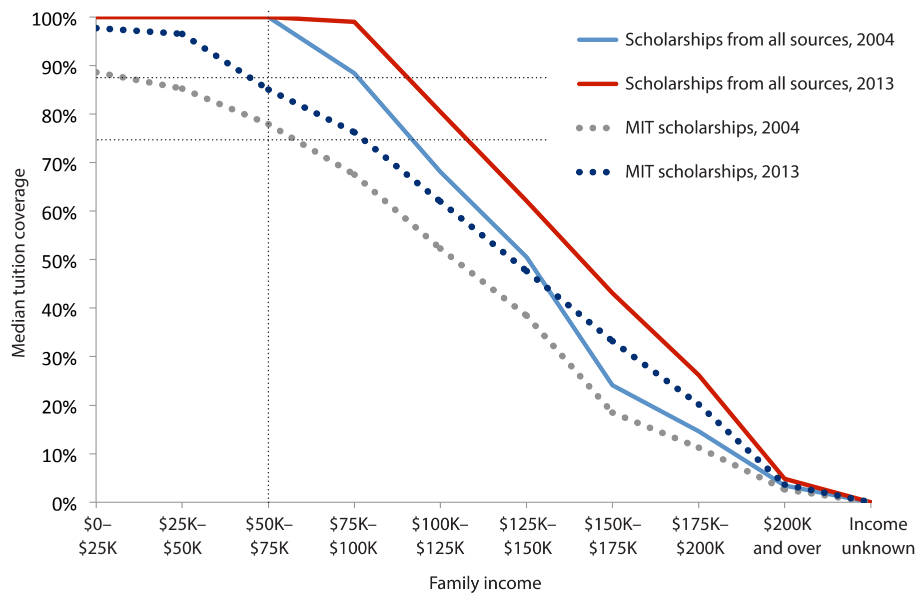


Source: MIT Student Financial Services

At MIT, the Institute is the highest provider of undergraduate financial aid, at 76% of aid. In the nation overall, the federal government provides the highest percentage. MIT provides mostly scholarships and very few loans, but nationally loans are the largest support mechanism. This allows MIT students to graduate with significantly less debt. About one-third of undergraduate students at MIT receive scholarships that cover the full cost of tuition. Families today are positioned to qualify for more aid and are incurring lower levels of debt.

Assuming that scholarships are first applied to the cost of tuition rather than room and board, the percentage of students receiving scholarships covering the full tuition price has increased over the past 10 years. During the 2003–2004 academic year, 75% of undergraduate families with incomes of less than $75,000 received scholarships covering the full tuition price. During the 2012–2013 academic year, 88% of families at this income level received scholarships covering the full tuition price (Figure 17).

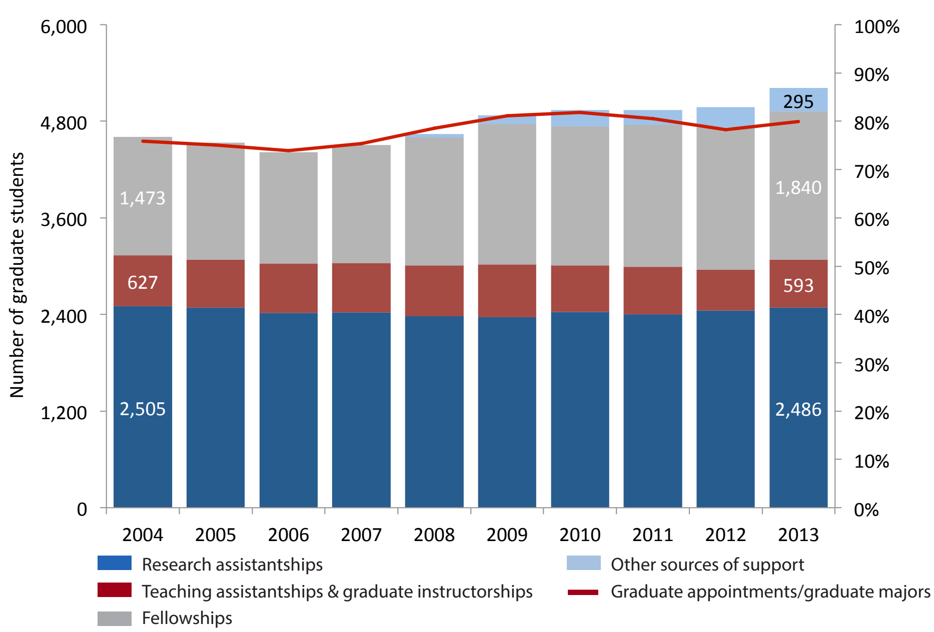
Figure 17. Median undergraduate tuition coverage by scholarships, AY2004 vs. AY2013 (inflation adjusted $2012)



Source: MIT Student Financial Services

Among graduate students, the largest source of support is from research assistantships (RAs) funded by sponsored research, MIT fellowships, and MIT teaching assistantships (TAs) and graduate instructorships (Figure 18). Forty percent of graduate students have RAs, 30% fellowships and 10% TAs or instructorships. As a result, tuition and stipend awards make up 88% of the financial aid received by graduate students. Student loans continue to play a significant role in the financing of a master's degree, especially for students attending the Sloan School of Management. In 2013, 32% of students receiving master's degrees, or 495 graduates, borrowed to finance their MIT graduate education and the average loan per borrower was $86,474. Three hundred thirty-nine of those graduates, or 68%, were Sloan students. This is in comparison to 6% of students receiving a PhD degree, or 32 graduates, borrowing an average of $24,745.

Figure 18. Sources of graduate student support, AY2004–AY2013



Source: MIT Institutional Research

To further enhance affordability for our undergraduate and graduate students, there is significant pressure on MIT to continually grow both sponsored research and endowment through market returns and philanthropy.

FUTURE SUSTAINABILITY OF MIT'S MODEL

By any measure we have studied, the MIT model is increasingly in demand, and it produces outstanding results in educating students and advancing knowledge. It is, however, a costly model that depends primarily on the ability to continue to attract philanthropic support and to generate investment returns.

The campus revenue mix has changed significantly from 1961, when research funding comprised 68% of revenue. Sixty-five percent of faculty members have active research programs today, and this percentage has remained fairly stable since 1997. Average research expenditures per faculty member have grown in constant dollars (2013) from $634,103 in 1997 to $815,596 in 2013. Median research expenditures in constant dollars have grown from $323,197 to $476,640 during this same time period. Today, while research expenditures have grown significantly, their percentage of campus revenue has dropped to 29%, with investment income growing from 3% of total in 1961 to 27% today.

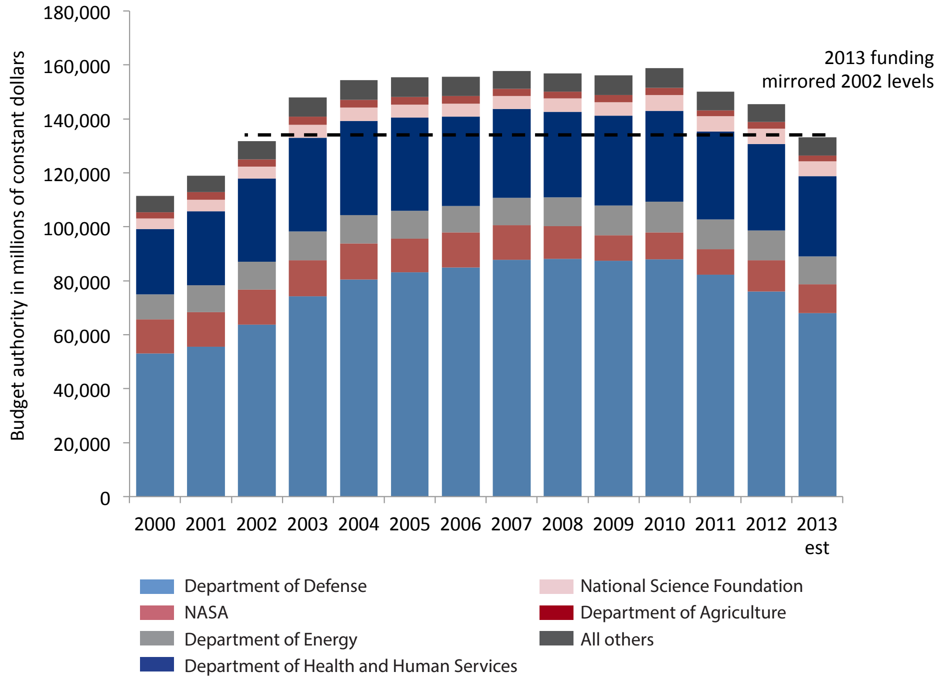
MIT has been quite fortunate in competing well for available research dollars, attracting the very best students, and growing the endowment through philanthropy and market returns. These results have allowed our vibrant research university to flourish beyond its initial conception.

At the same time, we face significant challenges.

1. Constrained federal funding has forced the Institute to grow and diversify our sponsored research portfolio to include greater portions of industrial and international support. As the overall pool of federal research funding shrinks, the mix of campus research sponsorship changes. Federal funding of campus research has reduced from almost 100% 50 years ago to 69% today (Figures 19 and 20).
2. Endowment returns and gift flows have typically followed macroeconomic trends, and we face a still-uncertain global economy and implied volatility (Figure 21). Investment support and gifts represent 38% of all campus annual revenues.
3. Academic and research space on campus has grown significantly over the past decades, to 5 million net assignable square feet, in order to accommodate the expansion of research and educational activities (Figure 22). We face the need to maintain and improve a great fraction of our world-class teaching and research infrastructure at considerable expense.
4. We also face the challenge of maintaining competitiveness in the recruitment of top talent without offsetting gains in productivity. This effect, known as Baumol's cost disease,[52] is caused by the need to compete for skilled workers in industries experiencing productivity gains.

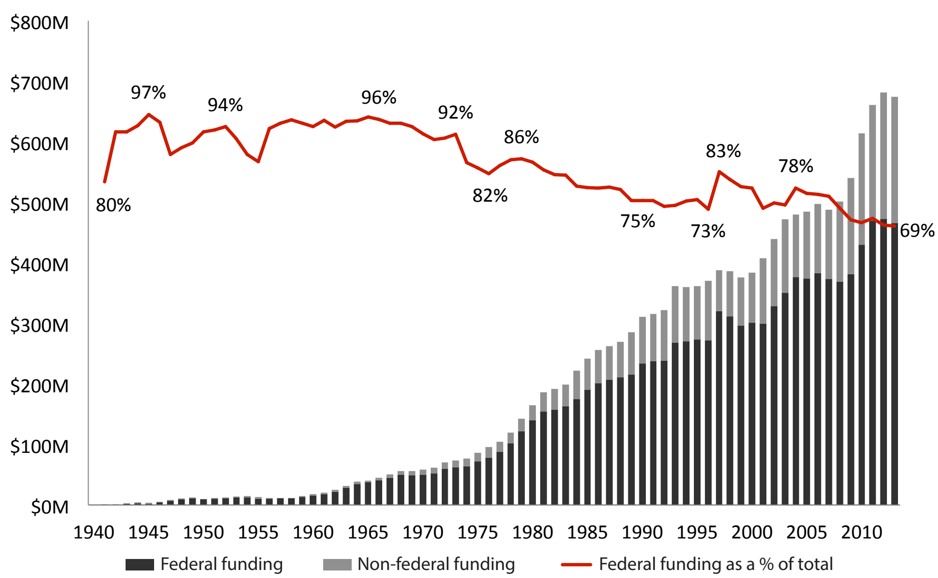
52. Baumol, William J. and William G. Bowen. *Performing Arts: The Economic Dilemma*. New York: The Twentieth-Century Fund; 1966.

Figure 19. Campus research and development budget authority, by agency, FY2000–FY2013



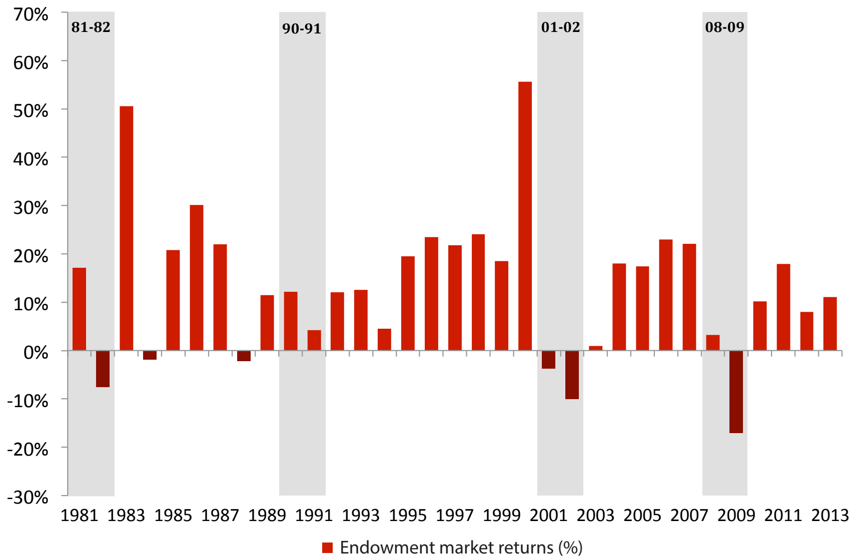
Source: American Association for the Advancement of Science R&D report series, based on Office of Management and Budget and agency R&D budget data

Figure 20. Campus federal funding as a proportion of total research funding, FY1940–FY2013



Source: MIT Institutional Research

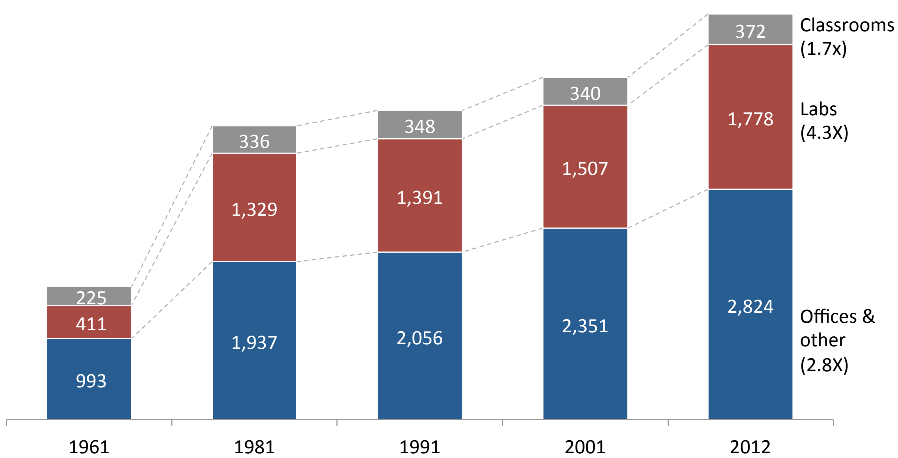
Figure 21. Market returns on MIT's endowment, FY1981–FY2013



Note: Endowment returns have typically followed macroeconomic trends.

Source: MIT Vice President for Finance

Figure 22. Growth in net assignable square feet of academic and research space on MIT campus, FY1961–FY2012



Source: MIT Space Accounting

The importance of increasing the resiliency of MIT's financial model is paramount. We will need to broaden our revenue base to balance volatility. We will need to increase the efficiency of the MIT educational model without disrupting the outcomes and exceptional quality that characterize an MIT education. We will need to maintain physical laboratories and spaces to high standards so that we continue to attract the best faculty and students to keep advancing scientific discoveries, knowledge, and innovation. And we will need to address the challenges of affordability and access, while adopting a financial model that can withstand the impacts of shifts in research funding or significant endowment volatility.

Providing the facilities required for our exceptional faculty, students, and researchers to advance research discovery and innovation is inherently expensive. With constrained research funding and a growing need to renew the campus, we need a mechanism that will allow us to meet the needs of research programs not yet imagined and continue our momentum as a premier research university. These challenges exist regardless of our involvement in online and global education. We will need to go beyond merely managing these resources and formulate a way to maximize use of existing space.

Our solution will need to be multi-pronged. We may need to slow the growth of new space, reduce our dependence on leased space, accelerate campus renewal, and develop flexible spaces that will enhance the residential experience. We will need to think creatively about incentives for increasing the density of occupants in new space, while taking old and low-quality space offline. New spaces will need to support the increasingly interdisciplinary and collaborative nature of our research and educational programs.

An improved understanding of how we use our space might inform how we can accommodate people to enhance collaborative activities, and expanded access to comprehensive space data might increase our collective awareness of the value of our facilities. The availability of this type of data could help guide us in strategic planning and allow us to quickly respond to potential changes in our student population, research endeavors, and financial position.

THE EVOLUTION OF MIT'S FINANCIAL MODEL

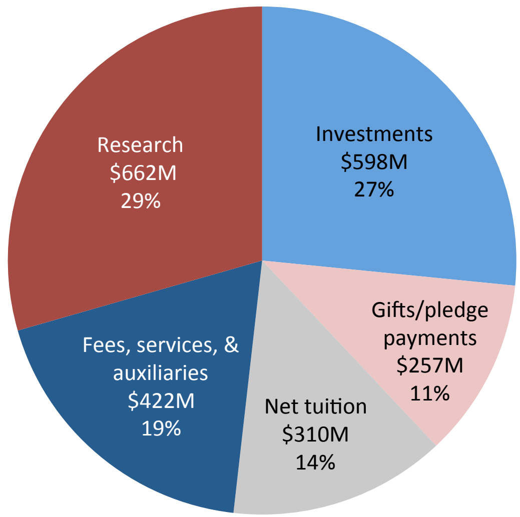
MIT today is an over $3 billion operation, including $891 million of research at Lincoln Laboratory. Excluding Lincoln, MIT's campus operations are funded through five major categories of operating revenue (Figure 23).

Research revenue ($662 million) includes reimbursements for direct research expenses (recognized when the expenses are incurred) as well as indirect research revenue earned to support centrally incurred expenses for administration, space (utilities, depreciation, interest) and other indirect costs as facilities and administrative (F&A) revenue.

Revenue support from investments ($598 million) consists primarily of distributions from MIT's endowment ($499 million) and income from all other investments, including non-endowed investments invested alongside the endowment in Pool A. (Assets and funds are pooled for investment purposes.)

Gifts and pledge payments ($257 million) include current expendable gifts received by the Institute along with payments on pledges made in prior years. Pledges received in the current year are not recognized as operating revenue, and are only recognized in the years the payments on the pledges are received.

Figure 23. Campus revenues, FY2013: $2.2B



Source: MIT Report of the Treasurer, year ending June 30, 2013

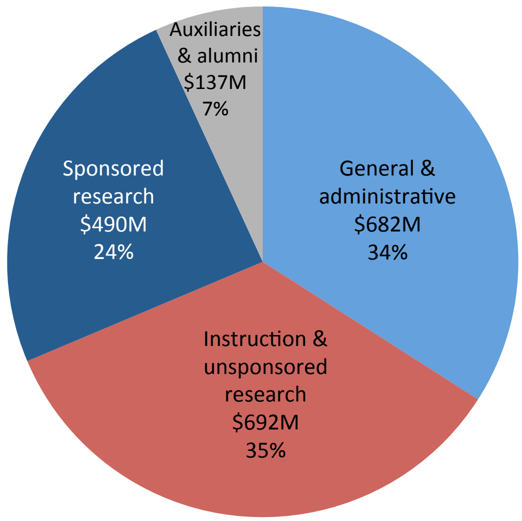
Net tuition ($310 million) is all tuition received by MIT, including tuition for executive and professional education, minus MIT-supported financial aid, which is treated as a "contra-revenue" instead of an expense according to accounting rules. Financial aid includes scholarships, fellowships, summer tuition remission, RA subsidies, and other tuition support provided by the Institute.

Fees, services, and auxiliaries revenues ($422 million) result from various other activities across the Institute. Auxiliaries ($114 million) include Housing, Dining, MIT Press, Endicott House, and Technology Review revenues. Fees and services include revenues earned through technology licensing, MIT Medical, the Department of Athletics, Physical Education and Recreation, the Industrial Liaison Program, parking, and other ancillary activities.

These sources of revenue fund MIT's faculty, research, and educational enterprise, facilities, and supporting functions.

MIT's expense structure can be segmented in many ways. The following view of functional expenses shows the campus expenses in 2013 were $2.0 billion (Figure 24). Of this total, $682 million, or 34%, was for general and administrative purposes. These expenses were for central administration, maintenance of facilities, payments on MIT's debt, and other non-instruction, non-research expenses.

Figure 24. Campus expenses, FY2013—Functional view: $2.0B



Source: MIT Report of the Treasurer, year ending June 30, 2013

Instruction and unsponsored research, $692 million or 35% of total campus expenses, includes expenses directly related to supporting instruction, such as faculty salaries, supplies to support courses, teaching assistants, and other instructional expenses. Unsponsored research is primarily internally funded research expenses not supported on any research contracts.

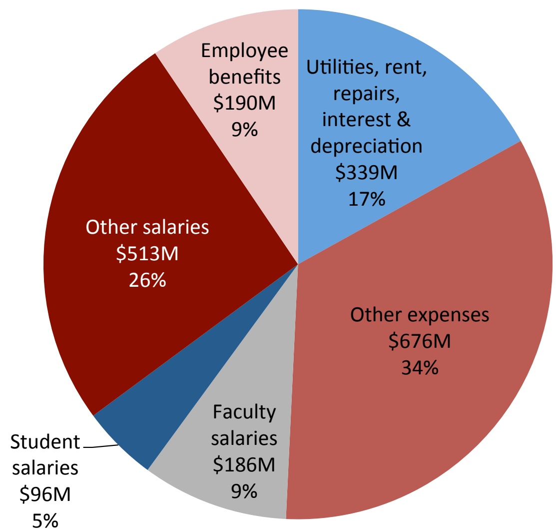
Sponsored research, $490 million or 24% of total campus expenses, is direct research expenses and does not include indirect expenses, which are covered in general and administration. This includes principal investigator salaries, research assistant costs that can be charged directly to grants, and any other expenses that can be charged directly to research contracts.

Auxiliaries and Alumni are expenses associated with operating Housing, Dining, MIT Press, Technology Review, Endicott House, and the Alumni Association.

Figure 25 shows a different way of slicing the same campus expenses, by what the money actually paid for. Salaries, wages, and employee benefits (SWEB) make up nearly 50% of all campus expenses, $985 million out of $2.0 billion. Campus salaries and wages can be broken out by faculty, student salaries (including RA and TA stipends), and other salaries. It does not include costs for temporary employees, consultants, and other contractors, which are included in other expenses. Employee benefits costs include those associated with medical, dental, parking, pension, postretirement medical, and other benefit programs offered to employees through MIT.

Utilities, rent, repair, interest, and depreciation costs ($339 million or 17% of total campus costs) include those costs associated with space on campus. These include costs to operate the central utility plant and to buy utilities from outside MIT; interest expenses on MIT's borrowings; depreciation on buildings, equipment, and other capitalized property; lease costs; and costs associated with maintaining MIT's physical infrastructure. It does not include capital investments in infrastructure and other capital assets, which are reflected on our balance sheet and show up as periodic depreciation expenses over the lives of the assets.

Figure 25. Campus expenses, FY2013—Natural view: $2.0B

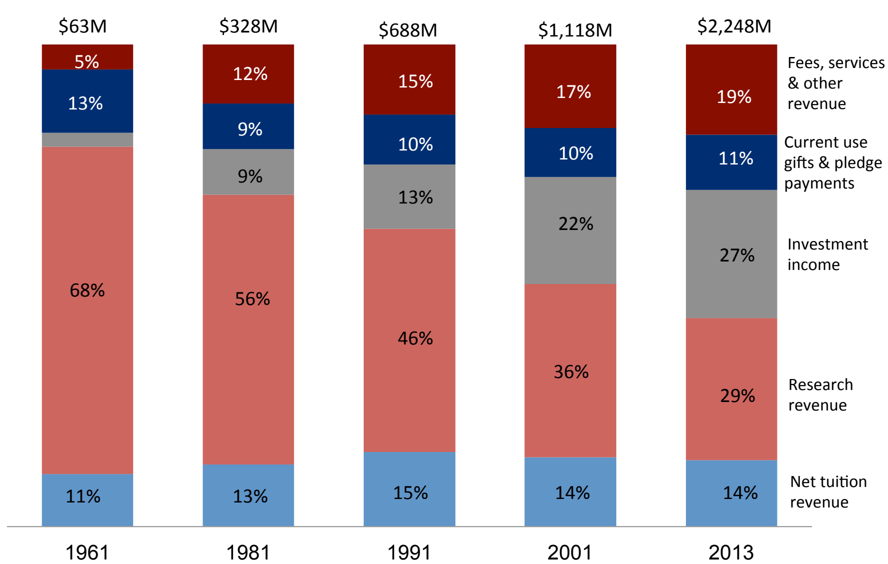


Source: MIT Report of the Treasurer, year ending June 30, 2013

Other operating expenses ($676 million or 34% of total campus costs) capture all remaining expenses at MIT. These items run the gamut from non-capital equipment to supplies and services, contractors, travel, and anything else MIT pays for that is not related to compensation or space.

It is clear from reviewing the historical figures that MIT's financial model evolved to adapt to the mission of MIT over many decades.

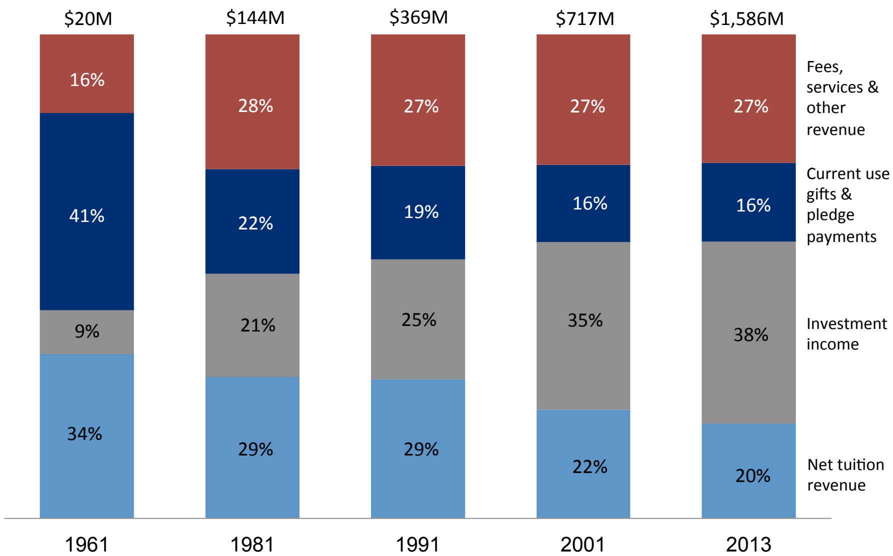
Figure 26. Evolution of campus revenue mix, FY1961–FY2013



Note: Excludes the Broad Institute, Lincoln Laboratory, and the Singapore-MIT Alliance for Research and Technology.

Source: MIT Vice President for Finance

Figure 27. Evolution of campus non-research revenue mix, FY1961–FY2013



Note: Excludes the Broad Institute, Lincoln Laboratory, and the Singapore-MIT Alliance for Research and Technology.

Source: MIT Vice President for Finance

Figures 26 and 27 illustrate how MIT's revenue mix has evolved over time, from being research-centric in the 1960s to being more reliant on investment income in recent years. In the throes of the space race and Cold War, MIT's research enterprise was its primary source of campus revenue, making up 68% in 1961.

However, as the model evolved, MIT diversified its revenue sources. As MIT's endowment grew and its investment returns improved substantially in the 1990s and 2000s, the revenue mix shifted toward heavier reliance upon investment income, which in turn provided the funding needed to expand MIT's research and education mission into new priorities such as life sciences. Of course, as noted before, this heavy reliance on investment income comes with the added risk of exposure to economic volatility, as MIT experienced during the financial crisis of 2008–2009, which resulted in our needing to reduce endowment payout rates by 18% in 2011 and adjust spending accordingly.

Another item of note is that net tuition has not been a major source of revenue, never comprising more than 16% of the campus total. We have also become somewhat more reliant upon fees and services, driven in part by technology licensing activities. Though MIT has experienced great success in fundraising over the years, as a proportion of total revenue it has remained relatively flat.

FRAMEWORK FOR MODELING FUTURE OPPORTUNITIES

The Working Group has been developing possible approaches to test scenarios emerging from Task Force discussions and evaluate financial impacts. It has also been considering opportunities to generate alternative revenue streams within the current model to provide increased flexibility in the future. In addition, we have been looking at ways to better support residential and global experiments that may be identified by the Task Force.

Revenue Opportunities

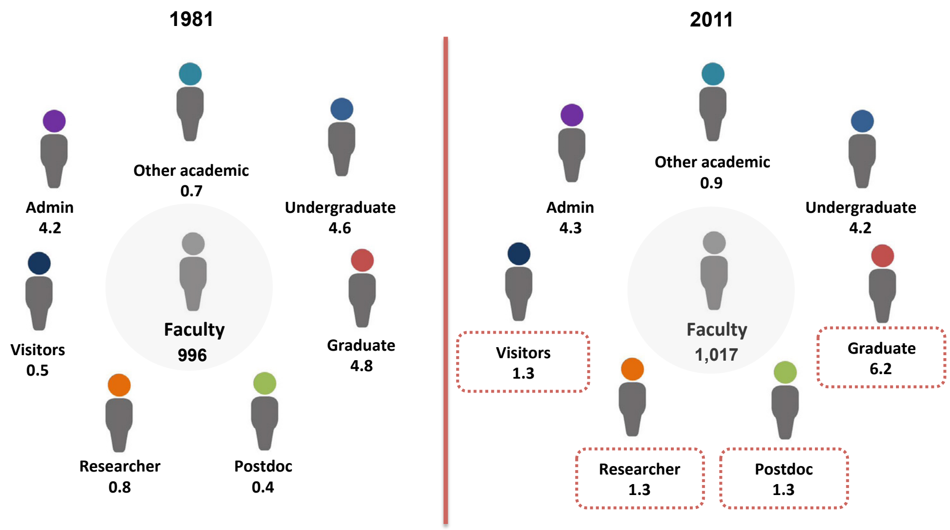
Preserving and enhancing the extraordinary research and educational environment at MIT is likely to require both a strengthening of existing income sources and consideration of new revenue opportunities. Two current sources of institutional support—government research funding and tuition—are likely to be under pressure, the former from ongoing federal budget pressures and the latter from growing interest among policy-makers and the public in slowing the growth of gross tuition prices and raising financial aid. It may be possible to increase the revenues generated from other existing sources of funds by raising the level of development activity to support increases in charitable gifts, and by expanding the scope of institutional and corporate partnerships.

Other strategies for enhancing revenues involve getting more resources from existing revenue streams, for example by hosting an expanded menu of summer programs and broadening the array of executive education activities by involving more faculty in both on-campus and off-campus initiatives. One potential new source of revenue to be explored is the use of digital learning technologies to leverage on-campus course instruction, coupled with some form of paid certification. One of the most difficult potential revenue streams to assess is the one associated with edX and related online learning initiatives. The experience of a number of programs at other universities may provide some guidance on the revenue possibilities in this sphere. Another possible new revenue source may involve more creative ways to engage the private sector in technology licensing. However, such an initiative is fraught with potential conflicts of interest with respect to MIT's educational mission, and this risk must be carefully weighed against any benefits from entrepreneurship.

MIT Operating Model—A Visual View

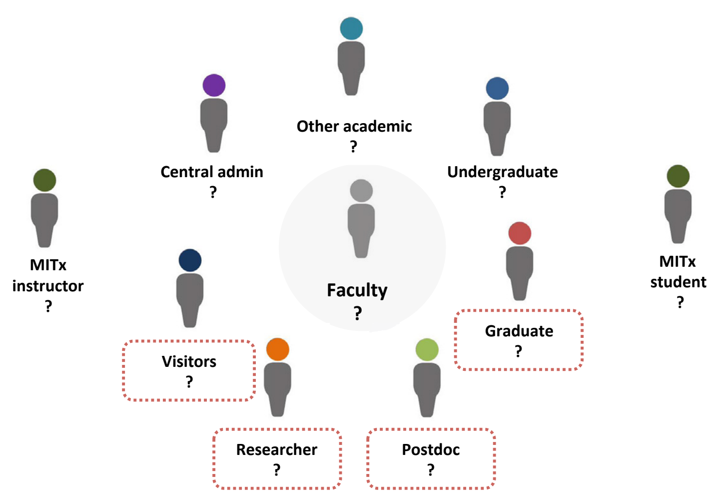
The number of MIT faculty has remained relatively constant over the past 30 years, with 996 faculty members in 1981 and 1,017 in 2011 (Figure 28). Similarly, the number of undergraduate students has remained constant, with 4.6 undergraduates per faculty member in 1981 and 4.2 undergraduates per faculty member in 2011. The numbers of graduate students, research staff, postdoctoral trainees, and visitors to MIT have all grown significantly as a result of the substantial growth in research funding over this same time period. The numbers of faculty and undergraduates have been strategically controlled, while the numbers of graduate students admitted and research staff hired have been determined at the departmental level. These changes in population on campus have evolved based on individual unit decisions with little opportunity for strategic integration. It is important to consider the faculty-undergraduate relationship as we work to reach more people and improve funding opportunities over the long term.

Figure 28. How we have evolved: Headcount 1981 vs. 2011



We now have the opportunity to influence the evolving campus population as we move into the future. Strategically increasing the undergraduate student-to-faculty ratio could have positive financial impact, but if pursued, this must occur without damaging the quality of the residential experience. Online experiences present new opportunities for envisioning educational roles for the future. For example, the roles of *MITx* instructor and *MITx* student may exist in 2020. As Task Force discussions continue, this model can be used to project how potential experiments might impact the campus population (Figure 29).

Figure 29. Looking forward: What will we look like in 2020?



MIT Operating Model—Operating Component View

The operating component view of the MIT operating model considers distinct categories of costs: Revenue-generating operations, academic and research expenditures, academic and research support services, student and residential services, administrative enabling services, and plant and capital costs.

Incremental Cost Framework

The incremental cost framework looks at operating costs—compensation, space-related expenses, supplies and services, and expense offsets (tuition, fees, room and board)—in relation to faculty with specific attributes or students enrolled in particular programs, in order to estimate the incremental financial impact of adding faculty and students under specified scenarios.

The incremental analysis framework is designed to support different combinations of faculty and student increases, with consideration of specific disciplines and associated needs. Recognizing the impact of housing on the cost of adding students, the framework supports various housing options—lower or average cost on-campus housing and off-campus housing. Using a scenario builder, we can study a variety of scenarios and resulting financial impacts.

CONTINUING OUR WORK

The questions we are trying to answer are complex and nuanced, and the public conversation about affordability and access is growing. The MIT model produces outstanding students and advances knowledge in extraordinary ways, yet we face significant challenges. We need to adopt a financial model that can weather the challenges of constrained federal funding, an uncertain global economy, and the need for campus renewal without disrupting the outcomes and exceptional quality that characterize an MIT education. It is a daunting task, but we are confident that the best approaches for enabling MIT for generations to come will emerge as we continue the Task Force work.

APPENDICES

Appendix 1. Presidential Charge to the Institute-wide Task Force on the Future of MIT Education

In a letter to the MIT Community on February 6, 2013, President Rafael Reif described the formation of an Institute-wide Task Force.

To the members of the MIT community:

With great optimism and excitement, I write to share the news that I am creating an Institute-Wide Task Force on the Future of MIT Education.

Reinventing what we do and how we do it

At my inauguration, I made the case that, thanks to the pressures of cost and the potential of new online teaching technologies, higher education is at a crossroads. As a result, we have a truly historic opportunity to better serve society by reinventing what we do and how we do it. I proposed that MIT should continue to use *MITx* and edX to create the best online education possible, in ways affordable and accessible for students far beyond our campus. And I challenged us all, in the great MIT spirit of learning by doing, to use our own campus community to invent the residential research university of the future.

Listening to our community and the wider world

Since then, in my listening tour across MIT, people have told me over and over how glad they are that MIT is helping to lead this educational revolution—and how important it is that we "get it right." Conversations with leaders in Washington and at the World Economic Forum have confirmed my view that we are rapidly reaching an inflection point in the history of higher education and that the outcome will be critically important for MIT, for colleges and universities in general, and for generations of students around the world.

Leadership of the Task Force

To help MIT assess and rise to the demands of this complex challenge, I am following a path many MIT presidents have followed successfully before me: I am creating an institute-wide task force that will draw on and focus this community's legendary capacity for rigorous analysis, technical know-how, creative problem-solving and thinking big.

To lead this effort, I have chosen two co-chairs: Professor Sanjay Sarma, who already serves as our Director of Digital Learning, and Executive Vice President and Treasurer Israel Ruiz SM '01. A member of the edX board, Israel also brings to the task a deep understanding of MIT's physical and financial resources and previous experience in leading such a complex "volunteer" effort, since he co-chaired the 2009–2011 Institute-Wide Planning Task Force that helped MIT find a creative path forward during the global financial downturn.

I am asking Sanjay and Israel to assemble the remaining members of the Task Force, including faculty, students, alumni and staff who can represent the broad interests of the MIT community. I expect that they will announce the list of members within a few weeks.

*   *   *

I encourage everyone to read my official charge to the Task Force, which describes its scope and purpose. We face big questions, with big consequences. To arrive at the best solutions, we will need to draw on the collective experience and wisdom of individuals and groups from across the MIT community. If we share our best thinking, informed by our highest aspirations for MIT, I have no doubt that we will come to answers that will serve our community and advance the larger conversation.

Sincerely,

L. Rafael Reif

Charge to the Institute-wide Task Force on the Future of MIT Education

Higher education is striving to respond to the forces of disruptive change. While many US students struggle to cover the cost of higher education, colleges and universities are straining to cover the cost of providing that education. Yet at the same moment, advances in online teaching technologies are opening up extraordinary new possibilities, suddenly making it possible to offer highly effective but comparatively low-cost advanced instruction to students on campus and to millions of learners around the world.

The positive implications for society are immense and impossible to fully foresee. And I am convinced that these forces offer us the historic opportunity to reinvent the residential campus model and perhaps redefine education altogether. Our society can only benefit if we improve what the residential research university does better than any other institution: Incubate brilliant young talent, and create the new knowledge and innovation that enrich our society and drive economic growth.

For MIT—an institution passionately committed to the kind of hands-on, team-focused, apprenticeship education that depends on community and human contact—the challenge and the opportunity are particularly urgent and direct. In short, to stay true to our educational values, we must seize the opportunity to reimagine what we do and how we do it. I raised this challenge at my inauguration. In the four months since, the stunning pace of change has proved that we are in the midst of an educational revolution.

MIT has already chosen to help lead one aspect of this revolution through edX and *MITx*, our ongoing experiments in online learning. But I believe we can and should take the lead in helping to invent the future of education more broadly—both on our campus and beyond. Defining this path and leading us toward a financially sustainable solution will be the charge of this Task Force.

Building on a legacy of educational innovation

MIT has helped lead the world to new educational frontiers before. In its very founding, with its bold insistence on learning by doing, MIT helped invent the educational model that turned the United States into an industrial success. In the 1950s, MIT rebuilt its engineering curriculum on a foundation of basic science. In the 1970s, MIT dared to make frontline research a routine part of the undergraduate learning experience through its now widely copied Undergraduate Research Opportunities Program (UROP). In the 1980s, with Project Athena MIT created a crucial prototype of the connected campus. In 2002, MIT launched the unprecedented experiment in free online sharing known as MIT OpenCourseWare. And in late 2011, we took the next step in online learning with the creation of *MITx*, followed shortly by edX, a partnership with Harvard University to launch a non-profit learning platform open to students and institutions around the world.

Today, I ask that this Task Force be bold—just as bold—in experimenting with ideas that would both enhance the education of our own students on our own campus and that would allow us to offer some version of our educational experience to learners around the world. Your explorations may lead you to answers that will have implications and applications far beyond MIT, and I encourage you to capture and consider those ideas as well.

This challenge is non-trivial, but you will be able to draw on a growing resource never available before: the rapidly evolving research on learning science, including the remarkable flow of data emerging from our own online learning efforts. Use this information to inspire your thinking. The future of education may include many possible models and scenarios. Experiments will be necessary, and as we learn more along this journey, we will need flexible thinking, reliable feedback and an “ecosystem” that helps us adapt. Help us imagine how to make that ecosystem work.

Leadership

Sanjay Sarma, Professor of Mechanical Engineering and Director of Digital Learning, and Israel Ruiz, EVP and Treasurer, will lead the Task Force as Co-Chairs.

Leveraging the wisdom of our community

In the best tradition of MIT, it is vital that we use this Task Force to expand discussion of these complex, critical issues to include all members of our community. I therefore ask that the Task Force move immediately to create a mechanism, such as an Idea Bank, that will allow people throughout the MIT community to contribute their experiences and recommendations. And although I propose below some preliminary questions to focus your discussions, I encourage you to solicit ideas and concerns from the MIT community, leverage existing research on education and identify additional areas of importance.

A commitment to transparency and communication

Because the Task Force will consider topics that go to the marrow of MIT, we owe the community a commitment to transparency and to regular communications about the progress of its work. I encourage you to suggest the most effective tools and approaches we can use to meet these commitments.

The Charge

So that you may advise me and MIT's administration, I charge the Task Force to:

- Propose an "ecosystem" for ongoing research, learning and innovation about the future of education.
- Recommend a range of possible experiments and pilot projects that will allow us to explore the future of MIT education:
  - *On our own campus*, in ways that incorporate online learning tools to the fullest extent while maximizing the value of face-to-face learning for both faculty and students.
  - *Beyond our campus*, through which learners around the world could benefit from important aspects of MIT's educational content, vision and values
- Evaluate the future strength and sustainability of MIT's current financial model in this evolving context and propose alternative or complementary approaches.
- Develop a roadmap that will describe the work streams and the phases of work necessary to enable this ecosystem and implement these experiments.

Proposed questions to be addressed:

1. What can we learn from the many examples of "blended models" of education, which seek to magnify the effectiveness of online instructional tools with in-person teaching?
2. MIT has traditionally used a four-year, two-semester system. More modular models are also being tested. What other approaches could emerge by 2020?
3. Online technologies have already proven very effective at *instruction*—the conveying of content. But as our graduates can attest, an MIT *education* clearly includes many learning experiences that can only occur in person. Today, the MIT learning experience involves several modes of interaction: lectures, recitations, labs, projects, internships, study groups, individual study and so on. It also features signature educational approaches such as UROP and MISTI (MIT International Science and Technology Internship program), and intensive project-based hands-on learning in many fields. What learning experiences will constitute an MIT education in 2020? Which elements would be enhanced by online technologies, and which truly demand interaction in person? What new experiences could courses incorporate?
4. How can MIT improve accessibility and affordability?
5. What are the implications for MIT's financial model and pricing structures?
6. What are the implications for MIT's physical spaces, including classrooms, research laboratories, residential spaces and common spaces?
7. What are the pathways and barriers, advantages and disadvantages, to extending important aspects of the MIT educational experience to vastly more learners than we could ever bring to our campus?

Working Groups

- Working Group on MIT Education and Facilities for the Future
- Working Group on the Future Global Implications of edX and the Opportunities It Creates
- Working Group on a New Financial Model for Education

Timeline and Results

I ask that you complete a preliminary report in approximately six months, for the start of the 2013–14 academic year. This initial report should include your initial findings on all the elements of the charge. I expect that your final report could be complete a year from now.

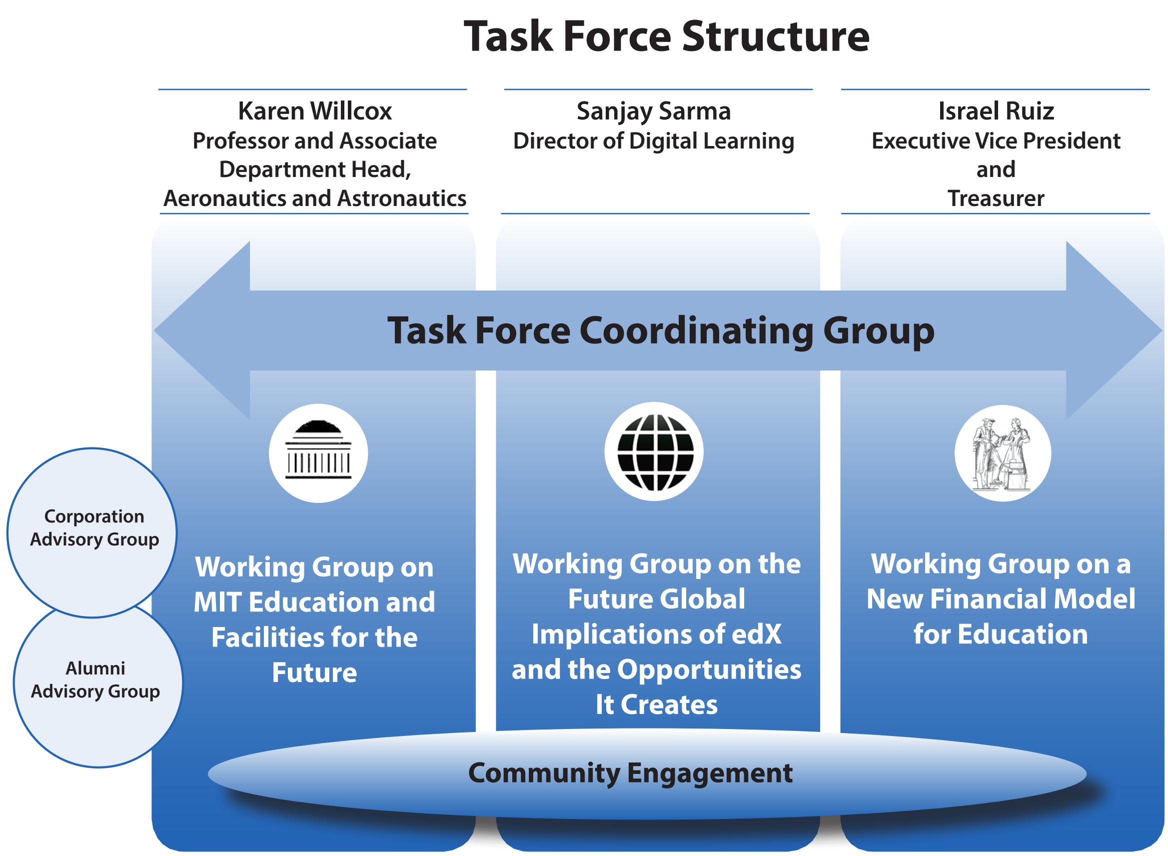
The task before you is serious and pressing. I hope it will also be fascinating, and I urge you to bring to it all of your creativity and your highest aspirations for MIT. MIT has long stood for openness, accessibility and educational innovation, and through your efforts, we can lead the way to a new realization of these ideals.

I am deeply grateful for your willingness to serve the Institute through this Task Force, and I believe your work will also serve the world.

Sincerely,

L. Rafael Reif

Appendix 2. Task Force Structure and Membership



Three Working Groups of Faculty, Students, and Staff

Working Group Membership includes faculty representing all five schools, staff and both undergraduate and graduate students, with approximately 50 individuals participating as members. The Task Force Coordinating Group is comprised of faculty, students, and staff representing the three working groups, and is designed to provide connectivity across the groups. Corporation and Alumni Task Force Advisory Groups were formed to provide insights and recommendations as the Task Force performs its work.

Task Force Membership

Task Force Co-Chairs

Israel Ruiz, Executive Vice President and Treasurer
Sanjay Sarma, Director of Digital Learning
Karen Willcox, Professor and Associate Department Head, Department of Aeronautics and Astronautics

Working Group on MIT Education and Facilities for the Future

Chair

Karen Willcox, Department of Aeronautics and Astronautics

Faculty

Samuel Allen, Department of Materials Science and Engineering
Deepto Chakrabarty, Department of Physics
Isaac Chuang, Department of Electrical Engineering and Computer Science
Catherine Drennan, Department of Chemistry
Dennis Freeman, Dean for Undergraduate Education
Daniel Hastings, Engineering Systems Division and Aeronautics and Astronautics
Daniel Jackson, Department of Electrical Engineering and Computer Science
SP Kothari, Sloan School of Management
Anne McCants, Department of History
Augustín Rayo, Department of Linguistics and Philosophy
Mitchel Resnick, Program in Media Arts and Sciences
Laura Schulz, Department of Brain and Cognitive Sciences
Nader Tehrani, Department of Architecture
Karen Willcox, Department of Aeronautics and Astronautics

Staff

Peter Bedrosian, Registrar's Office
Lori Breslow, Office of the Dean of Undergraduate Education

Students

Devin Cornish, Undergraduate, Department of Mechanical Engineering
Kuang Xu, Graduate, Department of Electrical Engineering and Computer Science

Working Group on the Future Global Implications of edX and the Opportunities It Creates

Chair

Sanjay Sarma, Director of Digital Learning

Faculty

Martin Culpepper, Department of Mechanical Engineering
Michael Cusumano, Sloan School of Management
Rick Danheiser, Department of Chemistry
Steven Eppinger, Sloan School of Management
Eugene Fitzgerald, Department of Materials Science and Engineering
Steven Hall, Chair of the Faculty
Sep Kamvar, Program in Media Arts and Sciences
Philip Khoury, Associate Provost
Eric Klopfer, Department of Urban Studies and Planning
Thomas Malone, Sloan School of Management
Christine Ortiz, Dean of Graduate Education
Sanjay Sarma, Director of Digital Learning
Hanna Rose Shell, Program in Science, Technology and Society
Hazel Sive, Department of Biology
Jacob White, Department of Electrical Engineering and Computer Science

Staff

Vijay Kumar, Office of Digital Learning, Office of Educational Innovation and Technology
Bhaskar Pant, MIT Professional Education

Students

Anubhav Sinha, Undergraduate, Department of Electrical Engineering and Computer Science
Ellan Spero, Graduate, Program in Science, Technology and Society

Working Group on a New Financial Model for Education

Chair

Israel Ruiz, Executive Vice President and Treasurer

Faculty

John Belcher, Department of Physics
Claude Canizares, Vice President
Andrew Lo, Sloan School of Management
James Poterba, Department of Economics
Craig Wilder, Department of History

Staff

Elizabeth Hicks, Office of Student Financial Services
Michael Howard, Vice President for Finance
Karl Koster, Corporate Relations
Israel Ruiz, Executive Vice President and Treasurer
Anthony Sharon, Office of the Executive Vice President and Treasurer

Rochelle Weichman, Sloan School of Management
Heather Williams, School of Science
David Woodruff, Office of the Vice President of Resource Development

Students

Patrick Hulin, Undergraduate, Department of Mathematics
George Chen, Graduate, Department of Electrical Engineering and Computer Science

Task Force Coordinating Group

Co-Chairs

Israel Ruiz, Executive Vice President and Treasurer
Sanjay Sarma, Director of Digital Learning
Karen Willcox, Department of Aeronautics and Astronautics

Faculty

Claude Canizares, Vice President
Michael Cusumano, Sloan School of Management
Daniel Jackson, Department of Electrical Engineering and Computer Science
Eric Klopfer, Department of Urban Studies and Planning
SP Kothari, Sloan School of Management
Anne McCants, Department of History
Hazel Sive, Department of Biology
Jacob White, Department of Electrical Engineering and Computer Science

Staff

Anthony Sharon, Office of the Executive Vice President and Treasurer
Heather Williams, School of Science

Students

Patrick Hulin, Undergraduate, Department of Mathematics
Ellan Spero, Graduate, Program in Science, Technology and Society

Task Force Corporation Advisory Group

Chair

Diana C. Walsh, President Emerita, Wellesley College

Members

Raja H.R. Bobbili, Student, JD/MBA Program, Harvard University
Vanu Bose, CEO, Vanu, Inc.
R. Erich Cauffield, New Orleans Federal Lead for White House Strong Cities, Strong Communities (SC2) Initiative
Diane B. Greene, Member, Board of Directors, Google Inc., Intuit and MIT
Brian G. R. Hughes, Chairman and Product Engineer, HBN Shoe, LLC

Robert B. Millard, Managing Partner, Realm Partners, LLC
Megan J. Smith, Vice President, Google X, Google, Inc.
Kenneth Wang, President, US Summit Company

Task Force Alumni Advisory Group

Chair

John W. Jarve ’78, President of the Association of Alumni and Alumnae of MIT, 2013–14

Members

Katy Brown ’93, SM ’96
Dan W. Butin ’90, Founding Dean of the School of Education at Merrimack College
John Gavenonis ’98, Global Technology Manager, Renewable/Sustainable Materials, E. I. Du Pont de Nemours, DuPont Performance Polymers
Bhavya Lal ’89, SM ’90, SM ’92, Core Staff Member at the Science and Technology Policy Institute
Thomas H. Massie ’93, SM ’96, U.S. Representative from Kentucky
Andrew N. Sutherland, Founder, Quizlet
Priyamvada Natarajan ’90, ’91, SM ’11 Professor of Astronomy and Physics, Yale University

Financial Data and Analysis Team

Liaison from Task Force Working Groups to Data Team

Michael Howard, Vice President for Finance

Staff

Christine Albertelli, Office of the Vice President for Finance
Deborah Leitch, Office of the Vice President for Finance
Allen Marcum, Office of the Vice President for Finance
Lydia Snover, Office of the Provost
Basil Stewart, Office of the Vice President for Finance

Appendix 3: Community Engagement

Community Engagement

In the best tradition of MIT, the Task Force is a collaborative and inclusive process where input from all parts of the community is sought, welcomed and valued. With the guidance of the Advisory Groups and input from the broader MIT community through the Idea Bank and group discussions, this work reflects the experiences and knowledge of the faculty, students, staff, members of the Corporation and alumni who contributed their expertise to these conversations.

Advisory Groups

Recognizing the magnitude and tremendous importance of this effort, two Advisory Groups were formed. The Corporation Advisory Group, chaired by Corporation and Executive Committee member Diana Chapman Walsh, provides insight and expertise and engages Corporation members more broadly in these discussions. The Alumni Advisory Group, chaired by President of the Association of Alumni and Alumnae of MIT John Jarve, will engage MIT's alumni in these discussions and provide opportunities to contribute to this work.

Idea Bank

An Idea Bank was created for the MIT community to contribute experiences and recommendations. The Idea Bank website, future.mit.edu, received visitors from 102 countries and saw 180 ideas submitted. Social networks joined the conversation, with more than 500 followers on Twitter and more than 100 followers on the Future of MIT Education Yammer group.

Engagement Meetings

A number of face-to face meetings have been held and are still ongoing to gather input and encourage engagement. This includes discussions at 22 academic department faculty meetings across the five schools, outreach sessions hosted by the Graduate Student Council and Undergraduate Association, table discussions at the spring 2013 Administrative Council meeting, and table discussions at the October Corporation dinner.

Surveys

A survey was conducted of the faculty and instructional staff designed to understand present and anticipated educational resource needs and how interactions between students and their instructors are changing. A student survey designed to better understand how students learn and interact with faculty, and what educational technologies students use was also carried out. Fifty-two percent of the faculty, 35% of the instructional staff, 35% of graduate students, and 39% of undergraduates responded to the two surveys.

List of Community Engagement Sessions

Meeting with Housemasters, April 17, 2013
Discussion with Task Force Co-chairs Sanjay Sarma and Israel Ruiz

Administrative Council Meeting, April 30, 2013
Table discussions captured and submitted to Idea Bank

Undergraduate Association Council meeting, May 7, 2013
Discussion with Task Force Co-chair Sanjay Sarma

Graduate Student Council–sponsored coffee hour at Sidney-Pacific graduate residence, June 12, 2013
Moderated discussion with approximately 50 participants

Academic Council, September 24, 2013
Discussion with Task Force Co-chairs Sanjay Sarma and Israel Ruiz

Research Council, October 10, 2013
Discussion with Task Force Co-chairs Sanjay Sarma and Israel Ruiz

Committee on the Undergraduate Program, October 23

Department Faculty Meeting Conversations with Task Force Working Group Chairs

School of Architecture and Planning

Media Arts and Sciences, September 16, 2013

Urban Studies and Planning, October 3, 2013

Architecture, October 9, 2013

School of Engineering

Chemical Engineering, September 9, 2013

Aeronautics and Astronautics, September 11, 2013

Mechanical Engineering, September 20, 2013

Engineering Systems, October 1, 2013

Materials Science and Engineering, October 3, 2013

Civil and Environmental Engineering, October 4, 2013

Nuclear Engineering, October 4, 2013

Electrical Engineering and Computer Science, October 21, 2013

Biological Engineering, November 18, 2013

School of Humanities, Arts and Social Sciences

Economics, October 30, 2013

Anthropology; Comparative Media Studies/Writing; Foreign Languages and Literatures; History; Linguistics and Philosophy; Literature; Music and Theatre Arts; Science, Technology and Society, November 4, 2013

Political Science, November 7, 2013

School of Science

Earth, Atmospheric and Planetary Sciences, September 26, 2013

Brain and Cognitive Sciences, September 27, 2013

Biology, October 21, 2013

Mathematics, October 24, 2013

Physics, October 24, 2013

Chemistry, November 5, 2013

Sloan School of Management, September 24, 2013

Idea Bank: Summary of Data and Themes

Idea Bank demographics and visitor information, April–July 2013

Type of participant*	Count
Alumnus/a	211
Current student	69
MIT faculty or instructor	20
MIT staff	89
Unknown/Other	40
Total	**429**

Page visits by country of origin	Count
United States	7,468
China	126
Canada	115
France	97
India	94
Australia	92
United Kingdom	66
Germany	51
Brazil	47
Spain	44
Remaining 92 countries	774
Total	**8,974**

Page visits by type of device	Count
Desktop	7,883
Mobile	667
Tablet	424
Total	**8,974**

*Includes all accounts created, most of which did not contribute to the discussion

Idea Bank: Ideas by Category

Number of ideas	Idea summary	New programs or paths	New courses or focuses	Integration of industry	The online platform	MIT in the world	The residential experience	Finances	Considerations/Concerns	Miscellaneous
23	Use online lectures to supplement, not replace, future residential classes				X		X			
16	Uncategorized									
9	Promote greater faculty–student interaction on campus to offset online education						X			
8	Reduce tuition, control costs							X		
6	Offer a cheaper three-year degree with stripped-down GIRs[a]	X			X		X	X		
6	Focus content to be more applied and connected to the real world			X						
6	Balance online and classroom education				X		X			
5	Offer different versions of the same course to fit different learning styles		X							
4	Integrate industry partners into classes across all departments			X				X		
4	Give credit for online education				X					
4	Create online courses for high school seniors to prepare them for college				X					
4	Reduce or adjust MIT's physical footprint to reflect a more online experience						X			
4	Actively promote group project and pset[b] work via expansion of group spaces						X			
3	Greater integration of internships for credit	X								
3	Focus on issues of sustainability on campus		X							

Idea Bank: Ideas by Category, continued

Number of ideas	Idea summary	New programs or paths	New courses or focuses	Integration of industry	The online platform	MIT in the world	The residential experience	Finances	Considerations/Concerns	Miscellaneous
3	Integrate one-on-one experience into online format				X					
3	Integrate new pedagogical advances made possible by web techologies				X					
3	Integrate living spaces with learning spaces, learn/work in small groups						X			
3	Focus on making online content accessible to all, including those with disabilities								X	
2	Break classes down into atomistic/bite-sized elements/goals that are linked across the entire Institute	X	X							
2	Add an alternative track to tenure for exceptional teachers/reward exceptional teachers	X								
2	Focus more on research methods, bring research experience online		X		X					
2	Include ethics module in online education		X							
2	Develop certification tests so students can prove their online education improved their skills				X		X			
2	Explore more options for real-time feedback in classes and online				X		X			
2	Involve MIT in projects aiming to improve education both locally and globally					X				
2	Use MIT's influence to promote conversation on science and technology worldwide					X				
2	Drop lectures in favor of more recitations						X			

Idea Bank: Ideas by Category, continued

Number of ideas	Idea summary	New programs or paths	New courses or focuses	Integration of industry	The online platform	MIT in the world	The residential experience	Finances	Considerations/Concerns	Miscellaneous
2	More tapings/live streams of classes for those who are sick/can't get to class						X			
2	Allow students to pay for tuition with a percentage of their future salary							X		
2	Improve transparency in financial aid							X		
2	Leave MIT the same								X	
2	Consider impact of online education on FSILGs[c], consider their importance in education								X	
2	Use metrics and a data-driven approach to determine the best course of action									X
1	Make all classes pass/fail	X	X							
1	Give students credit for creating content that helps other students learn	X								
1	Set up a formal teacher training program	X								
1	Teach smaller, shorter classes for subjects that don't need a full semester	X								
1	Move beyond course-focused education to concept-focused education	X								
1	Add a class in Course 6 which focuses on interdisciplinary collaboration, similar to 2.009		X							
1	Reintroduce classes focused on engineering a smarter power grid		X							
1	Increase focus on "grit"/self-efficacy		X							
1	Offer class on genocide history and prevention		X							

Idea Bank: Ideas by Category, continued

Number of ideas	Idea summary	New programs or paths	New courses or focuses	Integration of industry	The online platform	MIT in the world	The residential experience	Finances	Considerations/Concerns	Miscellaneous
1	Make HASS[d] classes more applied toward specific disciplines		X							
1	Host guest entrepreneurs in exchange for voluntary percentage of future wealth			X				X		
1	Increase focus on training PhDs for industrial leadership			X						
1	Create edX "satellite" campuses				X	X				
1	Traveling professors to teach supplementary material to edX courses				X	X				
1	Force online collaboration in MOOCs[e] by teams in different countries				X	X				
1	Allow online students to compete for "externships" with MIT through online course challenges				X					
1	Create physical spaces around the world for local edX recitation groups				X					
1	Use online platform for prerequisites				X					
1	License online platform to companies for their own internal learning				X					
1	Explore technologies to automate the video capture process for online classes				X					
1	Use edX to provide career education				X					
1	Create a MOOC[e] version of IAP[f]				X					
1	Cold-calling in online classrooms				X					

Idea Bank: Ideas by Category, continued

Number of ideas	Idea summary	New programs or paths	New courses or focuses	Integration of industry	The online platform	MIT in the world	The residential experience	Finances	Considerations/Concerns	Miscellaneous
1	Allow students to take online classes to get a taste of MIT before they choose to attend				X					
1	Allow the best online students to fill spots vacated by dropouts				X					
1	Allow students to submit media to fulfill course requirements in humanities MOOCs[e]				X					
1	Use influence to drive down journal prices to make them more affordable					X				
1	Encourage more students to live off campus						X			
1	Remove the "cap" on tuition—make it a flat percentage of income							X		
1	Utilize retired people as teachers, helpers									X
1	Improve functionality and depth of MIT directory									X
1	Make course evaluations due after exam period, hold grades if necessary									X
1	Make all intellectual property developed by anyone at MIT property of the inventor(s)									X
180										

[a] General Institute Requirements
[b] Problem sets
[c] Fraternities, sororities and independent living groups
[d] Humanities, Arts and Social Sciences
[e] Massive online open courses
[f] Independent Activities Period

Idea Bank: Notable Quotes, by Working Group

MIT Education and Facilities for the Future

My fraternity experience was positive and a major influence after graduation. Please remember student life as you work through the MIT of the future.	Alumnus/a
What about creating interdisciplinary academic programs focused on specific goals for improving the world?	Faculty/Staff
I do not want to see widespread changes in teaching techniques unless there is some quantitative evidence that they will actually lead to improvement for at least a set of students.	Current student
I find it very frustrating that course evaluations are due DURING exam period… Why can't we have evaluations due a week later?	Current student
Break MIT subjects into atomistic concepts that are linked across the entire institute… Students learn what they want to learn, and they can see how each concept builds upon others.	Alumnus/a
It would be nice to have a long project-type class (similar to 2.009) where Course 6 students could work with Course 2 students (or any other combinations of majors).	Current student
Set up a formal teacher training program, where part of a professor's bid for tenure is dependent on student evaluations.	Alumnus/a
I feel that there is a need for all MIT students to have the chance/opportunity to work as an intern in a company in their field of endeavor during a few semesters.	Faculty/Staff
Most [MIT PhD students] will work in private industry… PhD students [should] be prepared to become industry leaders when they leave their labs.	Alumnus/a
The bias of writing "simple" tests that simply require you to state information needs to be done away with. Instead, tests should focus on asking conceptual questions.	Current student
MIT [should] make research methods more of a focus: that classes focus as much on defining problems and identifying what topics need to be learned in order to solve them as they do on actually teaching those topics.	Current student

Idea Bank: Notable Quotes, by Working Group, continued

Global Implications of EdX & the Opportunities It Creates

Online learning enhances our modes of learning but cannot exist on its own. Instead of thinking of 'blended learning'—let's think of 'balanced learning'.	Faculty/Staff
Education is about more than just collecting facts—there is a critical social component as well. I think that no matter how technically deep one could go in an on-line course, it would still be 'MIT-lite.'	Alumnus/a
Whatever we do with online education, we need to be the world leader in making it as accessible and inclusive to the widest possible audience.	Faculty/Staff
A friend tells me of her dyslexic son, who's having a terrible time in college because his required courses are on line. He needs in-person classes to accommodate his disability, but his college isn't providing them.	Friend of MIT
Enhance the class experience by generating interaction among different kinds of groups. For example in a course, create a problem set that has to be solved by teams in different countries.	Faculty/Staff
Can we imagine an MIT where we don't have alumni, but life-long students who could 'come back' (for an additional fee) and get MIT (not MITx) credential for career advancement.	Faculty/Staff
Lectures can be recorded and put online. Then instead of lecturing, professors can have more sessions where they can answer questions, solve problems, and hold discussions.	Alumnus/a
What a campus and residential education should offer that the web basically cannot is a person to person connection—one generation training the next generation in how to think, to structure ideas, to solve problems.	Alumnus/a
I encourage the new direction to emphasize personal face-to-face interaction… The ILG system in the early '90s did this exceptionally well. If you just want knowledge, then online delivery is fine.	Alumnus/a
It is hard for me to imagine that non-residency could ever become a dominant mode at MIT. What about Labs—which even today are still a crucial part of most technical courses? What about team projects…?	Alumnus/a

Idea Bank: Notable Quotes, by Working Group, continued

A New Financial Model for Education

An option—rather drastic considering the logistics, but hugely beneficial financially to the student's family—is to offer a 3-year BS degree with minimal "liberal education" requirements.	Alumnus/a
I think students from every major could be tackling industry's problems to help fund their education, the same way we currently do with research as graduate students.	Alumnus/a
MIT would accept applications from entrepreneurs who wish to come to MIT to create new companies… They would have access to use of MIT resources and collaboration with MIT faculty, staff, and students.	Alumnus/a
I propose an option for undergraduates to pay for their education out of their salaries after they graduate. [How about] 5% of their income every year until the sum of the percentage points paid totals 100.	Current student
Significant dollars can be redirected back to universities from commercial publishers by the advocacy of publishing at reasonable prices. MIT is well positioned to lead in this transformation.	Faculty/Staff