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The MIT Washington Office was established in 1991 to provide a presence in the nation’s capital for MIT, one of the country’s premier academic institutions with a long history of contributing to U.S. leadership in science and technology. A part of the MIT President’s Office, the Washington Office works closely with the Institute’s senior leaders to develop and advance policy positions on R&D and education issues. The office also supports major MIT initiatives in areas where national policy is being developed, currently including advanced manufacturing and the innovation ecosystem; the convergence of the life, engineering and physical sciences; energy; the environment; and innovative educational technologies. MIT students work with the Washington Office to gain hands-on experience in the science and technology policy-making process.

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Facts and History

The Massachusetts Institute of Technology is one of the world’s preeminent research universities, dedicated to advancing knowledge and educating students in science, technology, and other areas of scholarship that will best serve the nation and the world. It is known for rigorous academic programs, cutting-edge research, a diverse campus community, and its longstanding commitment to working with the public and private sectors to bring new knowledge to bear on the world’s great challenges.

William Barton Rogers, the Institute’s founding president, believed that education should be both broad and useful, enabling students to participate in “the humane culture of the community” and to discover and apply knowledge for the benefit of society. His emphasis on “learning by doing,” on combining liberal and professional education, and on the value of useful knowledge continues to be at the heart of MIT’s educational mission.

MIT’s commitment to innovation has led to a host of scientific breakthroughs and technological advances. Achievements of the Institute’s faculty and graduates have included the first chemical synthesis of penicillin and vitamin A, the development of inertial guidance systems, modern technologies for artificial limbs, and the magnetic core memory that enabled the development of digital computers. Exciting areas of research and education today include neuroscience and the study of the brain and mind, bioengineering, energy, the environment and sustainable development, information sciences and technology, new media, financial technology, and entrepreneurship.

University research is one of the mainsprings of growth in an economy that is increasingly defined by technology. A study released in February 2009 by the Kauffman Foundation estimated that MIT graduates had founded 25,800 active companies. These firms employed about 3.3 million people, and generated annual world sales of $2 trillion, or the equivalent of the eleventh-largest economy in the world.

MIT has forged educational and research collaborations with universities, governments, and companies throughout the world, and draws its faculty and students from every corner of the globe. The result is a vigorous mix of people, ideas, and programs dedicated to enhancing the world’s well-being.
**Fields of Study**

MIT supports a large variety of fields of study, from science and engineering to the arts. MIT’s five academic schools are organized into departments and other degree-granting programs. In addition, several programs, laboratories, and centers cross traditional boundaries and encourage creative thought and research.

**School of Architecture and Planning**
- Architecture
- Media Arts and Sciences
- Urban Studies and Planning
- Center for Real Estate

**School of Engineering**
- Aeronautics and Astronautics
- Biological Engineering
- Chemical Engineering
- Civil and Environmental Engineering
- Electrical Engineering and Computer Science
- Engineering Systems
- Materials Science and Engineering
- Mechanical Engineering
- Nuclear Science and Engineering
- Institute of Medical Engineering and Science

**School of Humanities, Arts, and Social Sciences**
- Anthropology
- Comparative Media Studies/Writing
- Economics
- Global Studies and Languages
- History
- Humanities
- Linguistics and Philosophy
- Literature
- Music and Theatre Arts
- Political Science
- Science, Technology, and Society

**Sloan School of Management**
- Management

**School of Science**
- Biology
- Brain and Cognitive Sciences
- Chemistry
- Earth, Atmospheric, and Planetary Sciences
- Mathematics
- Physics

**Interdisciplinary Undergraduate Programs**
- American Studies
- Ancient and Medieval Studies
- Computer Science and Molecular Biology
- Program in Psychology
- Women’s and Gender Studies

**Interdisciplinary Graduate Programs**
- Computation for Design and Optimization
- Computational and Systems Biology
- Computational Science and Engineering
- Computer Science and Molecular Biology
- Engineering Systems
- Harvard-MIT Health Sciences and Technology Program
- Joint Program with Woods Hole Oceanographic Institution
- Leaders for Global Operations
- Microbiology
- Operations Research
- Polymer Science and Technology
- System Design and Management
- Technology and Policy
- Transportation
Digital Learning
Practically since the advent of digital computing, MIT has been at the forefront of innovation in educational technology, whether through individual faculty initiatives, departmental projects, or Institute-wide programs. Literally hundreds of technology projects, each building on the lessons of those before, have helped to change the face of education at MIT and throughout the global academic community.

But in the last few years, technology-enabled change in how we teach and learn has been accelerating. We have seen remarkable educational experiments throughout higher education that are resulting in unprecedented breakthroughs:

- **New pedagogies.** Examples include “flipped classrooms” (content delivery as homework and problem-solving/lab/customized instructor intervention in class), “chunked” (modularized) lessons, individually-paced/assessment-based teaching and learning, and machine-mediated frequent feedback to students. Many MIT faculty are experimenting with these new ways of teaching and learning.

- **Scalable teaching.** Innovative technologies such as robust learning management platforms with short videos, embedded quizzes with instant feedback, student-ranked questions that prioritize topical focus for instructors, automated grading and assessment, discussion forums, personalization, etc. make it possible to increase student cohort size from tens or hundreds in a campus classroom to tens of thousands around the globe via the Internet. MITx in partnership with edX—originally an MIT-Harvard alliance, which has since expanded to include many top-tier universities worldwide—brings MIT faculty and their “MOOC” courses to many thousands of learners everywhere.

- **Open educational resources (OER).** The OER movement, pioneered in large part by MIT’s OpenCourseWare project—and since joined by hundreds more institutions worldwide—lowers financial, geographical, and political barriers to accessing quality educational content.

- **Learning analytics and educational data mining.** Online learning systems have the ability to amass huge volumes of data on student use, navigation, and assessment as they work their way through courses. In the aggregate, these data can be used to model student learning approaches and performance. So, for example, it is now possible to monitor and predict students’ learning performance and spot potential issues early so that automated or instructor-initiated interventions can be provided. MIT faculty and other collaborators use these data for educational research to advance understanding of how people learn and identify effective pedagogical strategies.

- **Online software innovations.** New tools such as internet labs, gaming, MIT STAR (Software Tools for Academics and Researchers), and other resources provide adaptive learning aids that present educational materials according to students’ varying needs and learning styles. MIT faculty have conceived and implemented many teaching tools, simulations, and learning aids. One remarkable example: iLabs enriches science and engineering education by enabling students to use real instruments via remote online laboratories. Unlike conventional laboratories, iLabs can be shared via the Internet, delivering the educational benefits of hands-on experimentation both to our own students and to students around the world.

In 2012, MIT established the Office of Digital Learning (ODL) to harness the Institute’s educational technology resources to ensure that MIT remains at the forefront of developments like these. The new ODL integrates formerly independent organizational units related to digital learning into a structure that focuses on these strategic priorities:

1. Residential Education. Collaborate with faculty to explore, test, and institutionalize pedagogical models that enhance MIT education through digital and open learning technology and practices.
2. Open Education. Build out MIT’s edX portfolio with exemplary courses and modules, and continue to publish new and updated MIT course materials and other teaching/learning resources through MIT OpenCourseWare, enabling global access to MIT courses and ideas.

3. Strategic Education Initiatives. Undertake open education and digital learning experiments and implementations, sometimes in collaboration with other institutions.

4. Digital Learning Research. Encourage and support digital learning research across MIT, and seek opportunities to exchange data, research and lessons about digital learning.

http://odl.mit.edu/

Research Laboratories, Centers, and Programs
In addition to teaching and conducting research within their departments, faculty, students, and staff work in laboratories, centers, and programs.

Some of these include:

Center for Advanced Urbanism
Center for Archaeological Materials
Center for Biomedical Engineering
Center for Civic Media
Center for Collective Intelligence
Center for Computational Engineering
Center for Computational Research in Economics and Management Science
Center for Educational Computing Initiatives
Center for Energy and Environmental Policy Research
Center for Environmental Health Sciences
Center for Global Change Science
Center for Gynecopathology Research
Center for International Studies
Center for Materials Science and Engineering
Center for Real Estate
Center for Transportation and Logistics
Computer Science and Artificial Intelligence Laboratory
Deshpande Center for Technological Innovation
Division of Comparative Medicine

Francis Bitter Magnet Laboratory
Haystack Observatory
Institute for Medical Engineering and Science
Institute for Soldier Nanotechnologies
Institute for Work and Employment Research
Joint Program on the Science and Policy of Global Change
Knight Science Journalism Program
David H. Koch Institute for Integrative Cancer Research
Laboratory for Financial Engineering
Laboratory for Information and Decision Systems
Laboratory for Manufacturing and Productivity
Laboratory for Nuclear Science
Lean Advancement Initiative
Legatum Center for Development and Entrepreneurship
Lincoln Laboratory
Martin Trust Center for MIT Entrepreneurship
Materials Processing Center
McGovern Institute for Brain Research
Media Laboratory
Microsystems Technology Laboratories
MIT Catalyst Clinical Research Center
MIT Center for Art, Science, and Technology
MIT Center for Digital Business
MIT Energy Initiative
MIT Kavli Institute for Astrophysics and Space Research
MIT Portugal Program
MIT Professional Education
MIT Program in Art, Culture and Technology
MIT Sea Grant College Program
Nuclear Reactor Laboratory
Operations Research Center
Picower Institute for Learning and Memory
Plasma Science and Fusion Center
Research Laboratory of Electronics
Simons Center for the Social Brain
Singapore-MIT Alliance for Research and Technology
Sociotechnical Systems Research Center
Spectroscopy Laboratory

http://web.mit.edu/research/
Academic and Research Affiliations

**Collaborative Partnership edX**
A not-for-profit enterprise of its founding partners Harvard University and the Massachusetts Institute of Technology, edX is focused on transforming online and on-campus learning through ground-breaking methodologies, game-like experiences, and cutting-edge research on an open source platform. See pages 12-13 for more information.

**Idaho National Laboratory**
The Idaho National Laboratory (INL) is dedicated to supporting the U.S. Department of Energy’s missions in nuclear and energy research, science, and national defense. The INL established a National Universities Consortium (NUC) of universities from around the nation to engage in collaborative research in the nation’s strategic nuclear energy objectives. The NUC consists of MIT, Oregon State University, North Carolina State University, The Ohio State University, and University of New Mexico.

[https://www.inl.gov/inl-initiatives/education/nuc/](https://www.inl.gov/inl-initiatives/education/nuc/)

**Magellan Project**
The Magellan Project is a five-university partnership that constructed, and now operates, two 6.5-meter optical telescopes at the Las Campanas Observatory in Chile. The telescopes allow researchers to observe planets orbiting stars in solar systems beyond our own and to explore the first galaxies that formed near the edge of the observable universe. Collaborating with MIT on the Magellan Project are Carnegie Institute of Washington, Harvard University, University of Arizona, and University of Michigan.

**Massachusetts Green High Performance Computing Center**
The Massachusetts Green High Performance Computing Center (MGHPCC) is a collaboration of five of the state’s most research-intensive universities—Boston University, Harvard University, MIT, Northeastern University, and the University of Massachusetts—the Commonwealth of Massachusetts, CISCO, and EMC. The MGHPCC is a datacenter dedicated to providing the growing research computing capacity needed to support breakthroughs in science.

[http://www.mghpcc.org/](http://www.mghpcc.org/)

**MIT and Masdar Institute Cooperative Program**
A collaboration between MIT and the government of Abu Dhabi to establish a graduate research university focused on alternative energy, sustainability, and advanced technology. The MIT and Masdar Institute Cooperative Program supports Abu Dhabi’s goal of developing human capital for a diversified knowledge-based economy. See page 100 for more information.

**Northeast Radio Observatory Corporation**
The Northeast Radio Observatory Corporation (NEROC) is a nonprofit consortium of educational and research institutions that was formed in 1967 to plan an advanced radio and radar research facility in the Northeast. NEROC consists of nine educational and research institutions, these are MIT, Boston University, Brandeis University, Dartmouth College, Harvard University, Harvard-Smithsonian Center for Astrophysics, University of Massachusetts, University of New Hampshire, and Wellesley College.


**Singapore-MIT Alliance for Research and Technology Centre**
The Singapore-MIT Alliance for Research and Technology (SMART) Centre is a major research enterprise established by MIT in partnership with the National Research Foundation of Singapore. The SMART Centre serves as an intellectual hub for research interactions between MIT and Singapore at the frontiers of science and technology. See page 98 for more information.

[http://smart.mit.edu/](http://smart.mit.edu/)
**Facts and History**

**MIT Skoltech Initiative**
The MIT Skoltech Initiative is a multi-year collaboration between the Skolkovo Foundation, The Skolkovo Institute of Technology (Skoltech), and MIT to help conceive and launch a new concept for a graduate university focused on a small number of pressing global issues and designed to stimulate the development of a research and innovation ecosystem in Russia. See page 98 for more information.

**Synthetic Biology Engineering Research Center**
The Synthetic Biology Engineering Research Center (Synberc) is a multi-institution research effort to lay the foundation for synthetic biology. The core universities partners are MIT, University of California at Berkeley, University of California at San Francisco, Harvard University, and Stanford University. Synberc foundational research will be motivated by pressing biotechnology applications.  

http://synberc.org/

**Major Collaborator**

**Broad Institute**
The Broad Institute seeks to transform medicine by empowering creative and energetic scientists of all disciplines from across the MIT, Harvard, and Harvard-affiliated hospital communities to work together to address even the most difficult challenges in biomedical research. The Broad Institute was founded in 2003; Eli and Edythe Broad, MIT, and Harvard University were founding partners.

http://www.broadinstitute.org/

**Charles Stark Draper Laboratory**
Founded as MIT’s Instrumentation Laboratory, Draper Laboratory separated from MIT in 1973 to become an independent not-for-profit research and educational organization. Much of Draper’s current research and development focuses on problems that arise in the measurement, analysis, simulation, and control of complex dynamic systems. This research and development covers a wide range of application areas, including guidance, navigation and control, microsystems, complex reliable systems, autonomous systems, information and decision systems, biomedical and chemical systems, secure networking and communications, energy systems, and commercial space systems.

http://www.draper.com/

**Howard Hughes Medical Institute**
The Howard Hughes Medical Institute (HHMI) is a scientific and philanthropic organization that conducts biomedical research in collaboration with universities, academic medical centers, hospitals, and other research institutions throughout the country. Seventeen HHMI investigators hold faculty appointments at MIT.

http://www.hhmi.org/

**Ragon Institute of MGH, MIT and Harvard**
The Ragon Institute was established at Massachusetts General Hospital, MIT, and Harvard in February 2009. The Institute brings scientists and clinicians together with engineers in an interdisciplinary effort to better understand how the body fights infections and, ultimately, to apply that understanding against a wide range of infectious diseases and cancers. The dual mission of the Institute is to contribute to the discovery of an HIV/AIDS vaccine and the collaborative study of immunology.

http://ragoninstitute.org/

**Whitehead Institute for Biomedical Research**
The Whitehead Institute for Biomedical Research is a nonprofit, independent research institution whose research excellence is nurtured by the collaborative spirit of its faculty and the creativity and dedication of its graduate students and postdoctoral scientists. Whitehead’s primary focus is basic science, with an emphasis on molecular and cell biology, genetics and genomics, and developmental biology. Specific areas of inquiry at Whitehead include cancer, transgenic science, stem cells, regenerative biology, genetics, genomics, membrane biology, vertebrate development, and neurological disorders. Whitehead is affiliated with MIT through its members, who hold faculty positions at MIT. A small number of junior investigators also hold positions at Whitehead Institute as part of the Whitehead Fellows program.

http://wi.mit.edu/
Other Affiliation

MIT-Woods Hole Oceanographic Institution Joint Program in Oceanography and Applied Ocean Science and Engineering

The Woods Hole Oceanographic Institution (WHOI) is the largest independent oceanographic institution in the world. The MIT/WHOI Joint Program provides a high quality doctoral education leading to an internationally-recognized Ph.D. degree awarded by both institutions. The Joint Program is organized within five sub-disciplinary areas, each administered by a Joint Committee consisting of MIT faculty and WHOI scientists: Applied Ocean Science and Engineering, Biological Oceanography, Chemical Oceanography, Marine Geology and Geophysics, and Physical Oceanography.

http://mit.whoi.edu/

Naval Construction and Engineering

The graduate program in Naval Construction and Engineering (Course 2N) is intended for active duty officers in the U.S. Navy, U.S. Coast Guard, and foreign Navies who have been designated for specialization in the design, construction, and repair of naval ships. The curriculum prepares Navy, Coast Guard, and foreign officers for careers in ship design and construction and is sponsored by Commander, Naval Sea Systems Command. Besides providing the officers a comprehensive education in naval engineering, the program emphasizes their future roles as advocates for innovation in ship design and acquisition.

http://web.mit.edu/2n/

Reserve Officer Training Corps Programs

Military training has existed at MIT since students first arrived in 1865. In 1917, MIT established the nation’s first Army Reserve Officer Training Corps (ROTC) unit. Today, Air Force, Army, and Naval ROTC units are based at MIT. These programs enable students to become commissioned military officers upon graduation. More than 12,000 officers have been commissioned from MIT, and more than 150 have achieved the rank of general or admiral.

https://due.mit.edu/rotc/rotc-programs/

Study at Other Institutions

MIT has cross-registration arrangements with several area schools. At the undergraduate level, students may cross-register at Harvard University, Wellesley College, Massachusetts College of Art and Design, and the School of the Museum of Fine Arts. At the graduate level, qualified students may enroll in courses at Harvard University, Wellesley College, Boston University, Brandeis University, and Tufts University. International study opportunities including the Cambridge-MIT Exchange, departmental exchanges, and the MIT-Madrid Program are described on page 101.
Initiatives
Initiatives are created to serve the advancement of education and research. A selection of these initiatives are described here.

Convergence
Convergence is the merging of distinct technologies, processing disciplines, or devices into a unified whole that creates a host of new pathways and opportunities. It involves the coming together of different fields of study—particularly engineering, physical sciences, and life sciences—through collaboration among research groups and the integration of approaches that were originally viewed as distinct and potentially contradictory. Convergence means a broad rethinking of how all scientific research can be conducted, so that we capitalize on a range of knowledge bases, from microbiology to computer science to engineering design.

Convergence is a blueprint for innovation. It takes the tools and approaches of one field of study and applies them to another, paving the way for advances in all of the fields involved. Just as engineering and physical science are transforming the life sciences, biological models are transforming engineering and physical science: Advances in biofuels, biomaterials, and viral self-assembly are just a few examples of this reciprocal relationship.

A number of university-housed centers have already emerged as showcases of convergence, providing the intellectual and research space for life scientists to interact and collaborate with physical scientists and engineers. For example, the National Cancer Institute created Centers of Cancer Nanotechnology Excellence—one being the MIT-Harvard Center of Cancer Nanotechnology Excellence—for interdisciplinary and cross-university projects. These centers are pursuing a variety of activities, including developing nanoscale devices for targeted drug delivery, for diagnostics, for noninvasive brain imaging, and for molecular sensing of cancers, with an emphasis on prostate, brain, lung, ovarian, and colon cancers.

http://www.convergencerevolution.net/

Cybersecurity Initiatives
In 2015 MIT launched three campus-wide cybersecurity efforts aimed at addressing the technical, regulatory and managerial aspects of cybersecurity. The MIT Cybersecurity Policy Initiative (CPI), Cybersecurity@CSAIL, and the MIT Sloan’s Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity (IC)³ are intended to provide a cohesive, cross-disciplinary strategy to tackling the complex problems involved in keeping digital information safe.

Cybersecurity Policy Initiative (CPI) is overseen by the Vice President for Research and is administered by CSAIL. It is funded by a generous gift from the Hewlett Foundation and focuses a cross disciplinary engineering, social science and management team on developing a more sophisticated understanding of the security behavior of large-scale digital systems. The team will establish quantitative metrics and qualitative models to help inform and generate collaboration amongst decision makers in policy, industry, law, economics and technology.

Cybersecurity@CSAIL is focused on the technical aspects of preventing, working through and recovering from web-based attacks. The effort engages a small group of member companies and CSAIL researchers with the aim of addressing the technical challenges of cybersecurity more holistically. The CSAIL approach is to develop technologies that prevent even the most sophisticated attacks systematically rather than manage attacks retroactively.

MIT Sloan’s Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity (IC)³ addresses the strategic, managerial and operational issues related to cybersecurity of the nation’s critical infrastructure, ranging from energy and healthcare to financial services. An MIT cross disciplinary team lead by Sloan, along with industry partners, looks to address such issues as risk analysis, return on cybersecurity investment, application of cyber-safety models, incentives for more effective information sharing, methods for disrupting the cybercrime ecosystem, and metrics and models to better protect organizations.
Environmental Solutions Initiative
The Environmental Solutions Initiative (ESI) is designed to leverage the traditionally open atmosphere at MIT, which fosters interactions among people working in very different fields of study. That spirit of collaboration, and the possibilities it unleashes, are very powerful. ESI is designed to advance new interdisciplinary approaches spanning science, engineering, management, policy, and more to help drive the kind of progress required in time to make a difference.

MIT is already a powerhouse of environmentally oriented research and innovation. ESI is building on this vibrant foundation using seed grants to encourage new, cross-disciplinary research partnerships that advance progress and solutions on issues of environmental significance to humanity. A total of 59 teams of faculty, research staff and students responded to the first call for proposals, from which nine winners were announced on March 13, 2015. Projects will ramp up over the summer to start in September.

Education—both curricular and experiential—is also integral to ESI’s mission. Understanding the essential relationship between environmental quality and human welfare must become an essential part of MIT’s basic educational message delivered in the classroom, in the lab and in the field. To that end, ESI has formed a special Education Committee composed of faculty, staff and students to advance this agenda, with an immediate focus on creating a new Institute Minor in Environment and Sustainability.

http://environmentalsolutions.mit.edu/

Innovation Initiative
The MIT Innovation Initiative is an ambitious, Institute-wide multi-year agenda lead by faculty Co-Directors from the School of Engineering and the Sloan School of Management to transform the Institute’s innovation ecosystem—internally, around the globe, and with its partners—for accelerated impact well into the 21st century. It builds upon MIT’s foundation of fundamental research excellence and supports the aspirations for impact through innovation of all members of the MIT community. It supports MIT’s focus on solving a range of critical challenges in energy, the health of the planet, human health and beyond.

The Initiative advances four tightly connected parts designed to focus the Institute’s efforts on scalable innovation with impact:

- Focus on enhancing capabilities for idea-to-impact education and research. MIT strives to become the world leader in fostering idea-to-impact education—an approach to teaching and learning that doesn’t simply expand knowledge of an academic discipline, but contributes to our culture and economy. In addition, research is supplemented with activities and programs designed to extend the endpoint beyond publication to practical solutions to real world challenges.

- Foster innovation communities. In order to enable students, faculty and external partners to maximize impact on the innovation economy, we are fostering vibrant innovation communities that connect stakeholders across industries and sectors. These innovation communities bring together the five major stakeholder groups—entrepreneurs, academics, corporates, risk capitalists and government officials—to dive deeply into problem exploration, research and implementation of solutions at scale.
- Rewire our human capital, physical and digital infrastructure to accelerate innovation. We are creating new labs, new spaces for scale up, new funding mechanisms and new human capital roles on campus to foster innovation on a global scale. Through changes on campus as well as a global network of “innovation embassies” we are putting in place the foundations that provide the knowledge, tools and networks that empower our community to turn ideas into important solutions worldwide.

- Develop the science of innovation to inform action and policy. While the practice of innovation is an art, the innovation process—its drivers and outcomes—can be the subject of rigorous, multi-disciplinary analysis. The world is our laboratory, and so as we strive to increase our impact, the Innovation Initiative seeks to develop the science of innovation and understand how innovation is generated more constructively, efficiently and effectively. By evaluating our successes and failures, we are pioneering this new discipline, increasing our convening power in the global innovation economy and developing key evidence-based policy recommendations.

  http://innovation.mit.edu/

Abdul Latif Jameel World Water and Food Security Lab (J-WAFS)
The new Abdul Latif Jameel World Water and Food Security Lab (J-WAFS) serves to organize and promote food and water research around campus, emphasizing innovation and deployment of effective technologies, programs, and policies in order to have measurable impact as humankind adapts to a rapidly changing planet and combats water and food-supply scarcity. The lab aims to address the collective pressures of population growth, urbanization, development, and climate change—factors that endanger food and water systems in developing and developed countries alike. To accomplish this, the lab seeks to develop broad-based approaches employing MIT’s interdisciplinary strengths and expertise in science, engineering and technology, climate and hydrology, energy and urban design, business, social science, and policy. J-WAFS, as an interdepartmental lab reporting to the Vice President for Research, aims to spearhead the efforts of MIT’s faculty, labs, and centers to work towards solutions for water and food security that are environmentally benign and energy-efficient, including the development of transformative water and food technologies. These efforts will be supported in part through seed grants distributed competitively to MIT researchers from J-WAFS’ endowment, established in 2014 through a generous gift by alumnus Mohammed Abdul Latif Jameel ’78.

J-WAFS will also seek to partner with other institutions, foundations, industry, philanthropists, and governments to develop regionally appropriate solutions and innovations, whether for fast-growing megacities or for the rural developing world. Water supply in urban settings, for example, may benefit from conservation policies and infrastructure-scale systems, whereas rural populations may need small-scale, locally powered water purifiers. Ensuring stable food supplies requires a similarly varied approach that engages technology, biological and environment science, policy, and business innovation. J-WAFS also aims to support graduate student-driven food and water research and business communities on campus, through fellowships, conference sponsorship, and other mentoring and assistance.

  http://web.mit.edu/jwafs/
MIT Energy Initiative
The MIT Energy Initiative (MITEI) works to help transform global energy systems. It is a research, education, and outreach program that, in its depth and breadth, is without peer at U.S. academic institutions. An Institute-wide initiative, MITEI pairs MIT’s world-class research teams with key players across the innovation spectrum to help improve today’s energy systems and shape tomorrow’s global energy marketplace. It is also a resource for policy makers and the public, providing unbiased analysis and serving as an honest broker for industry and government. MITEI has more than 68 industry and public partners and has funded more than 128 novel or early-stage energy research projects submitted by faculty from across MIT.

MITEI’s educational offerings combine single-discipline depth with multidiscipline breadth, transforming the MIT campus into an energy learning laboratory. In the 2013–2014 academic year, the fifth and largest class of undergraduate Energy Minor students graduated from MIT: 35 students with majors from all five MIT Schools. Students overwhelmingly report positive experiences with the Minor, particularly regarding its multidisciplinary, project-based approach. MITEI is committed to ensuring that the Energy Minor experience continues to be powerfully integrative. This is an important challenge: teaching resources at MIT are typically distributed along departmental lines. Interdisciplinary subjects are not priorities for departmental resources, and thus we continue to seek creative ways to provide ongoing support for classes that bring faculty and instructors from multiple departments—even multiple schools—together to teach energy.

In June 2014, The Hoover Institution and MITEI released the product of a multiyear collaboration: Game Changers: Energy on the Move. The book, which highlights the historic and current effects of five research and development efforts from U.S. universities, stresses the importance of sustained support for basic energy research and development if the United States is to meet its goal of a cheaper, cleaner, and more secure national energy system.

Drawing from the efforts of Stanford University, MIT, and other leading university research centers, the book describes innovations that are transforming our energy landscape and how these innovations, now vital to our national energy economy, had their roots in previous university-based basic scientific research: natural gas from shale, solar photovoltaics, grid-scale electricity storage, electric cars, and LED lighting.

For more information on Game Changers, visit http://www.energygamechangers.org.

http://mitei.mit.edu/
Education Highlights

MIT has long maintained that professional competence is best fostered by coupling teaching with research and by focusing education on practical problems. This hands-on approach has made MIT a consistent leader in outside surveys of the nation’s best colleges. MIT was the first university in the country to offer curriculums in architecture (1865), electrical engineering (1882), sanitary engineering (1889), naval architecture and marine engineering (1895), aeronautical engineering (1914), meteorology (1928), nuclear physics (1935), and artificial intelligence (1960s). More than 4,000 MIT graduates are professors at colleges and universities around the world. MIT faculty have written some of the best-selling textbooks of all time, such as Economics by Paul A. Samuelson and Calculus and Analytic Geometry by George Thomas. The following are some notable MIT teaching milestones since 1968.

1968 MIT and Woods Hole Oceanographic Institute create a joint program for graduate studies in oceanography. This is the first higher education partnership of its kind.

1969 MIT launches the Undergraduate Research Opportunities Program (UROP), the first of its kind. The program, which enables undergraduates to work directly with faculty on professional research, subsequently is copied in universities throughout the world.

1970 The Harvard-MIT Program in Health Sciences and Technology is established to focus advances in science and technology on human health and to train physicians with a strong base in engineering and science.

1970 Department of Mechanical Engineering initiates the course 2.70 (now 2.007) design contest, created by professor Woodie C. Flowers. The competition was to build a mechanical device, out of a set of relatively simple wooden and metal parts, that would roll down a ramp at a precisely controlled rate.

1971 MIT holds its first Independent Activities Period (IAP), a January program that emphasizes creativity and flexibility in teaching and learning.

1974 The Minority Introduction to Engineering and Science (MITES) program is established to provide a rigorous six-week residential, academic summer program for promising high school juniors who are interested in careers in science and engineering.

1977 Whitaker College of Health Sciences, Technology, and Management is established to strengthen MIT’s ability to engage in health related research and education.

1977 MIT organizes the Program in Science, Technology, and Society to explore and teach courses on the social context and consequences of science and technology—one of the first programs of its kind in the U.S.

1981 MIT-Japan Program is created to send MIT students to Japan for internships. In 1994, the program becomes part of the MIT International Science and Technology Initiatives (MISTI). Today, the program also fosters research collaboration between faculty at MIT and in Asia through the MISTI Hayashi Seed Fund.

1981 MIT launches Project Athena, a $70 million program to explore the use of computers in education. Digital Equipment Corporation and IBM each contribute $25 million in computer equipment.

1981 The MIT Sloan School of Management launches its Management of Technology program, the world’s first master’s program to focus on the strategic management of technology and innovation.

1983 MIT establishes the Center for Real Estate and the first Master of Science in Real Estate Development (MSRED) degree program in the U.S.

1983–1990 MIT language and computer science faculty join in the Athena Language Learning Project to develop interactive videos that immerse students in the language and character of other cultures. The work pioneers a new generation of language learning tools.

1984 MIT establishes the Media Laboratory, bringing together pioneering educational programs in computer music, film, graphics, holography, lasers, and other media technologies.
1990 MIT initiates an artist-in-residence program to provide students with opportunities to interact with nationally and internationally recognized artists through master classes, lecture-demonstrations, performances and workshops.

1991 The Department of Mechanical Engineering’s course 2.70 (2.007) design contest goes international, with students competing from Japan, England and Germany.

1992 MIT establishes the MacVicar Faculty Fellows Program, named in honor of the late Margaret A. MacVicar, to recognize outstanding contributions to teaching. MacVicar, a professor of physics, had conceived of, designed, and launched UROP (see 1969, above).

1992 MIT launches the Laboratory for Advanced Technology in the Humanities to extend its pioneering work in computer- and video-assisted language learning to other disciplines. Its first venture was a text and performance multimedia archive for studies of Shakespeare’s plays.

1992 MIT Faculty approves the M.Eng. program in Electrical Engineering and Computer Science, an integrated five-year program leading to the simultaneous award of a bachelor’s and a master’s degree.

1993 In recognition of the increasing importance of molecular and cell biology, MIT becomes the first college in the nation to add biology to its undergraduate requirement.

1994 The MIT International Science and Technology Initiatives (MISTI) are created to connect MIT students to internships and research around the world. MIT’s primary international program, MISTI is a pioneer in applied international studies—a distinctively MIT concept.

1994 The MIT-China Program is created within MISTI to send MIT students to China for internships.

1995 The School of Engineering and the Sloan School of Management join to create a graduate program in system design and management (SDM), in which students can complete most course requirements at their job sites through interactive distance-learning.

1995 MIT’s Political Science Department establishes the Washington Summer Internship Program to provide undergraduates the opportunity to apply their scientific and technical training to public policy issues.

1997 The MIT-Germany Program is created within MISTI to send MIT students to Germany for internships.

1998 MIT teams up with Singapore’s two leading research universities to create a global model for long-distance engineering education and research. This large-scale experiment, the first truly global collaboration in graduate engineering education and research, is a model for today’s distance education.

1998 MIT-India Program is created within MISTI to send MIT students to India for internships.

1998 The Division of Bioengineering & Environmental Health (BEH) begins operation with the mission of fostering MIT education and research fusing engineering with biology.

1998 The School of Engineering establishes the Engineering Systems Division (ESD), focused on the development of new approaches, frameworks, and theories to better understand engineering systems behavior and design.

1999 MIT-Italy Program is created within MISTI to send MIT students to Italy for internships.

1999 The University of Cambridge and MIT establish the Cambridge-MIT Institute, whose programs include student and faculty exchanges, an integrated research program, professional practice education, and a national competitiveness network in Britain.

1999 MIT establishes the Society of Presidential Fellows to honor the most outstanding students worldwide entering the Institute’s graduate programs. With gifts provided by lead donors, presidential fellows are awarded fellowships that fund first year tuition and living expenses.
2000 MIT Faculty approve the Communication Requirement (CR), which went into effect for the Class of 2005. The CR integrates substantial instruction and practice in writing and speaking into all four years and across all parts of MIT's undergraduate program. Students participate regularly in activities designed to develop both general and technical communication skills.

2001 Studio Physics is introduced to teach freshman physics. Incorporating a highly collaborative, hands-on environment that uses networked laptops and desktop experiments, the new curriculum lets students work directly with complicated and unfamiliar concepts as their professors introduce them.

2001 MIT launches OpenCourseWare, a program that makes materials for nearly all of its courses freely available on the web and serves as a model for sharing knowledge to benefit all humankind.

2001 The MIT-France Program is created within MISTI to send MIT students to France for internships and enhance research collaboration between faculty at MIT and in France through the MIT-France Seed Fund.

2001 MIT establishes WebLab, a microelectronics teaching laboratory that allows students to interact remotely on the Web with transistors and other microelectronics devices anywhere and at any time.

2001 MIT’s Earth System Initiative launches TerraScope, a freshman course in which students work in teams to solve complex earth sciences problems. Bringing together physics, mathematics, chemistry, biology, management, and communications, the course has enabled students to devise strategies for preserving tropical rainforests, understand the costs and the benefits of oil drilling in the Arctic National Wildlife Refuge, and plan a mission to Mars.

2002 To give engineering students the opportunity to develop the skills they’ll need to be leaders in the workplace, MIT introduces the Undergraduate Practice Opportunities Program (UPOP). The program involves a corporate training workshop, job seminars taught by alumni, and a 10-week summer internship.

2003 MIT Libraries introduce DSpace, a digital repository that gathers, stores, and preserves the intellectual output of MIT’s faculty and research staff, and makes it freely available to research institutions worldwide. Within a year of its launch, DSpace material had been downloaded more than 8,000 times, and more than 100 organizations had adopted the system for their own use.

2003 MIT’s Program in Computational and Systems Biology (CSBi), an Institute-wide program linking biology, engineering, and computer science in a systems biology approach to the study of cell-to-cell signaling, tissue formation, and cancer, begins accepting students for a new Ph.D. program that will give them the tools for treating biological entities as complex living systems.

2004 The MIT-Mexico Program is created within MISTI to send MIT students to Mexico for internships.

2005 Combining courses from engineering, mathematics, and management, MIT launches its master’s program in Computation for Design and Optimization, one of the first curriculums in the country to focus on the computational modeling and design of complex engineered systems. The program prepares engineers for the challenges of making systems ranging from computational biology to airline scheduling to telecommunications design and operations run with maximum effectiveness and efficiency.

2006 MIT creates the Campaign for Students, a fundraising effort dedicated to enhancing the educational experience at MIT through creating scholarships and fellowships, and supporting multidisciplinary education and student life.

2006 The MIT-Spain Program is created within MISTI to send MIT students to Spain for internships.

2007 MIT makes material from virtually all MIT courses available online for free on OpenCourseWare. The publication marks the beginning of a worldwide movement toward open education that now involves more than 160 universities and 5,000 courses.
2008 The MIT-Israel Program is created within MISTI to train and send MIT students to Israel for internships; strengthen collaborations between MIT and Israel; and organize workshops, conferences, symposia and lectures at MIT and in Israel.

2009 MIT launches the Bernard M. Gordon-MIT Engineering Leadership Program. Through interaction with industry leaders, faculty, and fellow students, the program aims to help undergraduate engineering students develop the skills, tools, and character they will need as future engineering leaders.

2009 The MIT-Brazil Program is created within MISTI to send MIT students to Brazil for internships and encourage research collaboration between faculty at MIT and in Brazil through the MIT-Brazil Seed Fund.

2009 MIT introduces a minor in energy studies, open to all undergraduates. The new minor, unlike most energy concentrations available at other institutions, and unlike any other concentration at MIT, is designed to be inherently cross-disciplinary, encompassing all of MIT’s five schools. It can be combined with any major subject. The minor aims to allow students to develop expertise and depth in their major disciplines, but then complement that with the breadth of understanding offered by the energy minor.

2010 MIT introduces the flexible engineering degree for undergraduates. The degree, the first of its kind, allows students to complement a deep disciplinary core with an additional subject concentration. The additional concentration can be broad and interdisciplinary in nature (energy, transportation, or the environment), or focused on areas that can be applied to multiple fields (robotics and controls, computational engineering, or engineering management).

2011 MIT announces MITx, an online learning initiative that will offer a portfolio of free MIT courses through an online interactive learning platform. The Institute expects the platform to enhance the educational experience of its on-campus students and serve as a host for a virtual community of millions of learners around the world. The MITx prototype course—6.002x or “Circuits and Electronics”—debuts in March 2012 with almost 155,000 people registering for the course.

2012 MIT and Harvard University announce edX, a transformational new partnership in online education. Through edX, the two institutions will collaborate to enhance campus-based teaching and learning and build a global community of online learners. An open-source technology platform will deliver online courses that move beyond the standard model of online education that relies on watching video content and will offer an interactive experience for students. The University of California at Berkeley later joins edX. The three institutions offer the first edX courses in fall 2012.

2012 Lincoln Laboratory debuts a new outreach program—a two-week summer residential program for high-school students. The program, Lincoln Laboratory Radar Introduction for Student Engineers, focuses on radar technology. The project-based curriculum is based on a popular class offered during MIT’s Independent Activities Period (IAP) and taught by Laboratory technical staff. While the instructors adapted the IAP course to suit high-school students, they retained the challenging nature of the original class. The goal of the program is that students take away not only an understanding of radar systems but also the realization that engineering is about problem-solving and applying knowledge in innovative ways.
Research Highlights

The following are selected research achievements of MIT faculty and staff over the last five decades.

1967 Joel Moses, William A. Martin, and others develop MACSYMA, a computer program that manipulates algebraic quantities and performs symbolic integration and differentiation.

1968 Radar-based lunar studies are performed by Lincoln Laboratory. The use of radar to map the surface of the moon becomes possible when the radar beam is made small enough to discriminate between two points on the surface that would contribute echoes at the same range and Doppler shift. Altitude data is added to the two-dimensional radar reflectivity data by the use of interferometry. In addition, from the strength of radar reflections, it is estimated that the lunar surface has weight-bearing properties similar to that of terrestrial sand.

1969 Ioannis V. Yannas begins to develop artificial skin—a material used successfully to treat burn victims.

1970 David Baltimore reports the discovery of reverse transcriptase, an enzyme that catalyzes the conversion of RNA to DNA. The advance, which led to a Nobel Prize for Baltimore in 1975, provided a new means for studying the structure and function of genes.

1972 Lincoln Laboratory’s Moving Target Detector (MTD) achieved a new performance level for the detection of aircraft in the presence of radar clutter, such as ground, weather, and birds. It employed an antenna with two fan beams to provide coverage from the immediate vicinity of an airport to a distance of 60 nautical miles. The MTD became the world-recognized standard for Airport Surveillance Radar.

1973 Jerome Friedman and Henry Kendall, with Stanford colleague Richard Taylor, complete a series of experiments confirming the theory that protons and neutrons are made up of minute particles called quarks. The three receive the 1990 Nobel Prize in Physics for their work.

1974 Samuel C. C. Ting, Ulrich Becker, and Min Chen discover the “J” particle. The discovery, which earns Ting the 1976 Nobel Prize in Physics, points to the existence of one of the six postulated types of quarks.

1975 The Lincoln Laboratory Experimental Test System (ETS) becomes operational. The ETS is used for deep-space surveillance, daylight satellite tracking, searching the geostationary belt, and making astronomical measurements.

1975–1977 Barbara Liskov and her students design the CLU programming language, an object-oriented language that helps form the underpinnings for languages like Java and C++. As a result of this work and other accomplishments, Liskov later wins the Turing Award, considered the Nobel Prize in computing.

1975–1982 Joel Moses develops the first extensive computerized program (MACSYMA) able to manipulate algebraic quantities and perform symbolic integration and differentiation.

1976 H. Gobind Khorana and his research team complete chemical synthesis of the first human-manufactured gene fully functional in a living cell. The culmination of 12 years of work, it establishes the foundation for the biotechnology industry. Khorana won the 1968 Nobel Prize in Physiology/Medicine for other genetics work.

1977 Phillip Sharp discovers the split gene structure of higher organisms, changing the view of how genes arose during evolution. For this work, Sharp shared the 1993 Nobel Prize in Physiology/Medicine.

1977 Ronald Rivest, Adi Shamir, and Leonard Adleman invent the first workable public key cryptographic system. The new code, which is based on the use of very large prime numbers, allows secret communication between any pair of users. Still unbroken, the code is in widespread use today.

1979 The high frame rate required for airborne laser radar demands an array of photomixers, and Lincoln Laboratory begins a design study in binary optics for a solution. A hologram is proposed to generate an array of beams with the amplitude and phase distributions necessary to ensure efficient photomixing.

1979 Robert Weinberg reports isolating and identifying the first human oncogene—an altered gene that causes the uncontrolled cell growth that leads to cancer.
1981 Alan Guth publishes the first satisfactory model, called cosmic inflation, of the universe’s development in the first 10–32 seconds after the Big Bang.

1982 Alan Davison discovers a new class of technetium compounds that leads to the development of the first diagnostic technetium drug for imaging the human heart.

1982 Lincoln Laboratory utilizes a new generation of digital signal processing chips to develop a compact linear predictive coding (LPC) vocoder small and inexpensive enough for wide distribution. A vocoder analyzes and synthesizes speech using parameters that can be encrypted and transmitted at a much lower bit rate than the original speech waveform. The LPC vocoder is important in the U.S. development of secure voice systems.

1985 Susumu Tonegawa describes the structure of the gene for the receptors—“anchor molecules”—on the white blood cells called T lymphocytes, the immune system’s master cells. In 1987, Tonegawa receives the Nobel Prize in Physiology/Medicine for similar work on the immune system’s B cells.

1985 The Terminal Doppler Weather Radar (TDWR) program is initiated at Lincoln Laboratory to develop an automated system for detecting weather hazards in the airport terminal area and to help pilots avoid them. A successful TDWR prototype led to the procurement of 47 TDWRs from Raytheon in the 1990s, and there has not been a major U.S. wind-shear-related accident since 1994.

1986 Stephen Benton creates the first free-standing hologram. In 1985, Benton began generating synthetic holograms from 3-D digital databases, initially creating a 3-D image of a green car floating in front of the Boston skyline.

1986 H. Robert Horvitz identifies the first two genes found to be responsible for the process of cell death, which is critical both for normal body development and for protection against autoimmune diseases, cancer, and other disorders. Going on to make many more pioneering discoveries about the genetics of cell death, Horvitz shares the 2002 Nobel Prize in Physiology/Medicine for his work.

1988 Project Daedalus sets distance and endurance records for human-powered aircraft in a flight over the Aegean Sea.

1988 Sallie Chisholm and associates report the discovery of a form of ocean plankton that may be the most abundant single species on earth.

1989 The Airport Surveillance Radar (ASR)-9, developed at Lincoln Laboratory, provides air traffic control (ATC) personnel with a display free of clutter and a telephone bandwidth data stream for transmitting information to ATC facilities. The technology was later transferred to Westinghouse Corporation, which deployed the ASR-9 at 137 sites in the United States for the Federal Aviation Administration.

1990 Julius Rebek, Jr. and associates create the first self-replicating synthetic molecule.

1990 Building on the discovery of the metathesis—the process of cutting carbon-carbon double bonds in half and constructing new ones—Richard Schrock devises a catalyst that greatly speeds up the reaction, consumes less energy, and produces less waste. A process based on his discovery is now in widespread use for efficient and more environmentally friendly production of important pharmaceuticals, fuels, synthetic fibers, and many other products. Schrock shares the 2005 Nobel Prize in Chemistry for his breakthrough.

1991 Cleveland heart doctors begin clinical trials of a laser catheter system for microsurgery on the arteries that is largely the work of Michael Feld and his MIT associates.

1992 The Lincoln Laboratory Microelectronics Laboratory becomes operational. It is a 70,000 sq ft state-of-the-art semiconductor research and fabrication facility supporting a wide range of programs: flight-quality gigapixel charge-coupled device (CCD) imager focal planes, photon-counting avalanche photodiode arrays, and niobium-based superconducting circuits, to name a few. The Microelectronics Laboratory also supports advanced packaging with a precision multichip module technology and an advanced three-dimensional circuit stacking technology.
1993 H. Robert Horvitz, together with scientists at Massachusetts General Hospital, discover an association between a gene mutation and the inherited form of amyotrophic lateral sclerosis (Lou Gehrig’s disease).

1993 David Housman joins colleagues at other institutions in announcing a successful end to the long search for the genetic defect linked with Huntington’s disease.

1993 Alexander Rich and postdoctoral fellow Shuguang Zhang report the discovery of a small protein fragment that spontaneously forms into membranes. This research will lead to advances in drug development, biomedical research, and the understanding of Alzheimer’s and other diseases.

1993 The Traffic Alert and Collision Avoidance System (TCAS) is deployed. TCAS reduces midair collisions by sensing nearby aircraft and issuing an advisory to the pilot. Lincoln Laboratory developed the surveillance technology used by TCAS and built and flight-tested the TCAS prototype. Now mandated on all large transport aircraft, TCAS has been in operation for over a decade and has been credited with preventing several catastrophic accidents.

1994 MIT engineers develop a robot that can “learn” exercises from a physical therapist, guide a patient through them, and—for the first time—record biomedical data on the patient’s condition and progress.

1995 The Advanced Land Imager (ALI) is developed at Lincoln Laboratory to validate new technologies that (1) could be utilized in future land-observing satellites and (2) would reduce mass, size, and power consumption while improving instrument sensitivity and image resolution.

1995 Scientists at the Whitehead Institute for Biomedical Research and MIT create a map of the human genome and begin the final phase of the Human Genome Project. This powerful map contains more than 15,000 distinct markers and covers virtually all of the human genome.

1996 A group of scientists at MIT’s Center for Learning and Memory, led by Matthew Wilson and Nobel laureate Susumu Tonegawa, use new genetic and multiple-cell monitoring technologies to demonstrate how animals form memory about new environments.

1997 MIT physicists create the first atom laser, a device that is analogous to an optical laser but emits atoms instead of light. The resulting beam can be focused to a pinpoint or made to travel long distances with minimal spreading.

1998 MIT biologists, led by Leonard Guarente, identify a mechanism of aging in yeast cells that suggests researchers may one day be able to intervene in, and possibly inhibit, the aging process in certain human cells.

1998 Lincoln Near Earth Asteroid Research (LINEAR) is developed by Lincoln Laboratory to detect and catalogue near-Earth asteroids (NEAs) that may threaten Earth. Applying technology originally developed for the surveillance of Earth-orbiting satellites, LINEAR uses two ground-based electro-optical deep-space surveillance telescopes.

1998 An interdisciplinary team of MIT researchers, led by Yoel Fink and Edwin L. Thomas, invent the “perfect mirror,” which offers radical new ways of directing and manipulating light. Potential applications range from a flexible light guide that can illuminate specific internal organs during surgery to new devices for optical communications.

1999 Michael Cima, Robert Langer, and graduate student John Santini report the first microchip that can store and release chemicals on demand. Among its potential applications is a “pharmacy” that could be swallowed or implanted under the skin and programmed to deliver precise drug dosages at specific times.

1999 Alexander Rich leads a team of researchers in the discovery that left-handed DNA (also known as Z-DNA) is critical for the creation of important brain chemicals. Having first produced Z-DNA synthetically in 1979, Rich succeeds in identifying it in nature in 1981. He also discovers its first biological role and receives the National Medal of Science for this pioneering work in 1995.

2000 Scientists at the Whitehead Institute/MIT Center for Genome Research and their collaborators announce the completion of the Human Genome Project. Providing about a third of all the sequences assembled, the Center was the single largest contributor to this international enterprise.
2000 Researchers develop a device that uses ultrasound to extract a number of important molecules noninvasively and painlessly through the skin. They expect that the first application will be a portable device for noninvasive glucose monitoring for diabetics.

2000 Researchers from the MIT Sloan School of Management launch the Social and Economic Explorations of Information Technology (SeeIT) Project, the first empirical study of the effects of information technology (IT) on organizational and work practices. Examining IT’s relationship to changes in these models, SeeIT provides practical data for understanding and evaluating IT’s business and economic effects, which will enable us to take full advantage of its opportunities and better control its risks.

2001 In a step toward creating energy from sunlight as plants do, Daniel Nocera and a team of researchers invent a compound that, with the help of a catalyst and energy from light, produces hydrogen.

2002 MIT researchers create the first acrobatic robotic bird—a small, highly agile helicopter for military use in mountain and urban combat.

2002–2005 Scientists at MIT, the Whitehead Institute for Biomedical Research, and the Broad Institute complete the genomes of the mouse, the dog, and four strains of phytoplankton, photosynthetic organisms that are critical for the regulation of atmospheric carbon dioxide. They also identify the genes required to create a zebrafish embryo. In collaboration with scientists from other institutions, they map the genomes of chimpanzees, humans’ closest genetic relative, and the smallest known vertebrate, the puffer fish.

2003 Enhanced Regional Situation Awareness (ERSA) system is developed by Lincoln Laboratory for the U.S. Air Force to provide improved defense of the airspace surrounding the National Capital Region (NCR). ERSA capabilities have improved airspace surveillance, threat assessment and decision support, distribution of a common air picture to multiple agencies, and new ways to respond to aircraft violating the NCR airspace.

2003 MIT scientists cool a sodium gas to the lowest temperature ever recorded—a half-a-billionth of a degree above absolute zero. Studying these ultra-low temperature gases will provide valuable insights into the basic physics of matter; and by facilitating the development of better atomic clocks and sensors for gravity and rotation, they also could lead to vast improvements in precision measurements.

2004 MIT’s Levitated Dipole Experiment, a collaboration among scientists at MIT and Columbia, generates a strong dipole magnetic field that enables them to experiment with plasma fusion, the source of energy that powers the sun and stars, with the goal of producing it on Earth. Because the hydrogen that fuels plasma fusion is practically limitless and the energy it produces is clean and doesn’t contribute to global warming, fusion power will be of enormous benefit to humankind and to earth systems in general.

2004 A team, led by neuroscientist Mark Bear, illuminates the molecular mechanisms underlying Fragile X Syndrome and shows that it might be possible to develop drugs that treat the symptoms of this leading known inherited cause of mental retardation, whose effects range from mild learning disabilities to severe autism.

2004 Shuguang Zhang, Marc A. Baldo, and recent graduate Patrick Kiley, first figure out how to stabilize spinach proteins—which, like all plants, produce energy when exposed to light—so they can survive without water and salt. Then, they devise a way to attach them to a piece of glass coated with a thin layer of gold. The resulting spinach-based solar cell, the world’s first solid-state photosynthetic solar cell, has the potential to power laptops and cell phones with sunlight.

2005 MIT physicists, led by Nobel laureate Wolfgang Ketterle, create a new type of matter, a gas of atoms that shows high-temperature superfluidity.

2005 Vladimir Bulovic and Tim Swager develop lasing sensors based on a semiconducting polymer that is able to detect the presence of TNT vapor subparts per billion concentrations.
2006 MIT launches the MIT Energy Initiative (MITEI) to address world energy problems. Led by Ernest J. Moniz and Robert C. Armstrong, MITEI coordinates energy research, education, campus energy management, and outreach activities across the Institute.

2007 Rudolf Jaenisch, of the Whitehead Institute for Biomedical Research, conducts the first proof-of-principle experiment of the therapeutic potential of induced pluripotent stem cells (iPS cells), using iPS cells reprogrammed from mouse skin cells to cure a mouse model of human sickle-cell anemia. Jaenisch would then use a similar approach to treat a model of Parkinson’s disease in rats.

2007 Marin Soljačić and his colleagues develop a new form of wireless power transmission they call WITricity. It is based on a strongly coupled magnetic resonance and can be used to transfer power over distances of a few meters with high efficiency. The technique could be used commercially to wirelessly power laptops, cell phones, and other devices.


2007 Tim Jamison discovers that cascades of epoxide-opening reactions that were long thought to be impossible can very rapidly assemble the Red Tide marine toxins when they are induced by water. Such processes may be emulating how these toxins are made in nature and may lead to a better understanding of what causes devastating Red Tide phenomena. These methods also open up an environmentally green synthesis of new classes of complex highly biologically active compounds.

2007 MIT mathematicians form part of a group of 18 mathematicians from the U.S. and Europe that maps one of the most complicated structures ever studied: the exceptional Lie group E8. The “answer” to the calculation, if written, would cover an area the size of Manhattan. The resulting atlas has applications in the fields of string theory and geometry.

2008 Mriganka Sur’s laboratory discovers that astrocytes, star-shaped cells in the brain that are as numerous as neurons, form the basis for functioning brain imaging. Using ultra high-resolution imaging in the intact brain, they demonstrate that astrocytes regulate blood flow to active brain regions by linking neurons to brain capillaries.

2008 A team, led by Marc A. Baldo, designs a solar concentrator that focuses light at the edges of a solar power cell. The technology can increase the efficiency of solar panels by up to 50 percent, substantially reducing the cost of generating solar electricity.

2008 Daniel Nocera creates a chemical catalyst that hurls one of the obstacles to widespread use of solar power—the difficulty of storing energy from the sun. The catalyst, which is cheap and easy to make, uses the energy from sunlight to separate the hydrogen and oxygen molecules in water. The hydrogen can then be burned, or used to power an electric fuel cell.

2009 Lincoln Laboratory, building on its expertise in sensors and architectures, develops and demonstrates the Lincoln Distributed Disaster Response System, which enables information from airborne platforms, distributed weather stations, GPS-enabled devices, and other sources to be shared by responders at the emergency command centers and by those equipped with ruggedized laptops at the front lines. The system design initially focuses on fighting a large-scale fire but is also applicable for any large-scale disaster response.

2009 A team of MIT researchers, led by Angela Belcher, reports that it is able to genetically engineer viruses to produce both the positively and negatively charged ends of a lithium-ion battery. The battery has the same energy capacity as those being considered for use in hybrid cars, but is produced using a cheaper, less environmentally hazardous process. MIT President Susan Hockfield presents a prototype battery to President Barack Obama at a press briefing at the White House.
2009 Researchers at MIT’s Picower Institute for Learning and Memory show for the first time that multiple interacting genetic risk factors may influence the severity of autism symptoms. The finding could lead to therapies and diagnostic tools that target the interacting genes.

2009 Gerbrand Ceder and graduate student Byoungwoo Kang develop a new way to manufacture the material used in lithium ion batteries that allows ultrafast charging and discharging. The new method creates a surface structure that allows lithium ions to move rapidly around the outside of the battery. Batteries built using the new method could take seconds, rather than the now standard hours, to charge.

2009 Li-Huei Tsai’s laboratory describes mechanisms that underlie Alzheimer’s disease and propose that inhibition of histone deacetylases is therapeutic for degenerative disorders of learning and memory. Her laboratory also discovers the mechanisms of action of the gene Disrupted-in-Schizophrenia 1 and demonstrates why drugs such as lithium are effective in certain instances of schizophrenia. This research opens up pathways to discovering novel classes of drugs for devastating neuropsychiatric conditions.

2010 A new approach to desalination is being developed by researchers at MIT and in Korea that could lead to small, portable desalination units that could be powered by solar cells or batteries and could deliver enough fresh water to supply the needs of a family or small village. As an added bonus, the system would remove many contaminants, viruses, and bacteria at the same time.

2010 Yang Shao-Horn, with some of her students, and visiting professor Hubert Gasteiger, reports that lithium-oxygen (also known as lithium-air) batteries with electrodes with either gold or platinum as a catalyst have a higher efficiency than simple carbon electrodes. Lithium-air batteries are lighter than the conventional lithium-ion batteries.

2010 A team at Media Lab, including Ramesh Raskar, visiting professor Manuel Oliveira, student Vitor Pamplona, and postdoctoral research associate Ankit Mohan, create a new system to determine a prescription for eyeglasses. In its simplest form, the test can be carried out using a small, plastic device clipped onto the front of a cellphone’s screen.

2010 MIT releases The Future of Natural Gas report. The two-year study, managed by the MIT Energy Initiative, examines the scale of U.S. natural gas reserves and the potential of this fuel to reduce greenhouse-gas emissions. While the report emphasizes the great potential for natural gas as a transitional fuel to help curb greenhouse gases and dependence on oil, it also stresses that it is important as a matter of national policy not to favor any one fuel or energy source in a way that puts others at a disadvantage.

2010 Michael Strano and his team of graduate students and researchers create a set of self-assembling molecules that can turn sunlight into electricity; the molecules can be repeatedly broken down and reassembled quickly just by adding or removing an additional solution.

2011 Elazer Edelman, HST graduate student Joseph Franses, and former MIT postdoctoral fellows Aaron Baker and Vipul Chitalia show that cells lining blood vessels secrete molecules that suppress tumor growth and prevent cancer cells from invading other tissues, a finding that could lead to a new cancer treatment.

2011 The Alpha Magnetic Spectrometer (AMS)—an instrument designed to use the unique environment of space to search for antimatter and dark matter and to measure cosmic rays—is delivered to the International Space Station. The AMS experiment, led by Samuel C. C. Ting, is designed to study high-energy particles; such study could lead to new theories about the formation and evolution of the universe.
**Facts and History**

**2011** A team, including Karen Gleason, Vladimir Bulović, and graduate student Miles Barr, develops materials that make it possible to produce photovoltaic cells on paper or fabric, nearly as simply as printing a document. The technique represents a major departure from the systems typically used to create solar cells, which require exposing the substrates to potentially damaging conditions, either in the form of liquids or high temperatures.

**2011** By combining a physical interface with computer-vision algorithms, researchers in MIT’s Department of Brain and Cognitive Sciences create a simple, portable imaging system that can achieve resolutions previously possible only with large and expensive lab equipment. The device could allow manufacturers to inspect products too large to fit under a microscope and could also have applications in medicine, forensics, and biometrics. Moreover, because the design uses multiple cameras, it can produce 3-D models of an object, which can be manipulated on a computer screen for examination from multiple angles.

**2011** Researchers, led by Daniel Nocera, have produced an “artificial leaf”—a silicon solar cell with different catalytic materials bonded onto its two sides. The artificial leaf can turn the energy of sunlight directly into a chemical fuel that can be stored and used later as an energy source.

**2011** Lincoln Laboratory researchers, led by technical staff member Gregory Charvat, build a new radar technology system that can see through walls up to 60 feet away, creating an instantaneous picture of the activity on the other side. The system also creates a real-time video of movement behind the wall at the rate of 10.8 frames per second.

**2012** NASA’s Gravity Recovery And Interior Laboratory (GRAIL) twin spacecraft successfully enters lunar orbit. By precisely measuring changes in distance between the twin orbiting spacecraft, scientists will construct a detailed gravitational model of the moon that will be used to answer fundamental questions about the moon’s evolution and its internal composition. GRAIL’s principal investigator is Maria Zuber.

**2012** Researchers, including Jeffrey Grossman, discover that building cubes or towers of solar cells—to extend the cells upward in three-dimensional configurations—generates two to 20 times the power produced by fixed flat panels with the same base area.

**2012** Researchers, led by Ian Hunter, have engineered a device that delivers a tiny, high-pressure jet of medicine through the skin without the use of a hypodermic needle. The device can be programmed to deliver a range of doses to various depths—an improvement over similar jet-injection systems that are now commercially available.

**2012** A clinical trial of an Alzheimer’s disease treatment developed at MIT finds that a nutrient cocktail can improve memory in patients with early Alzheimer’s. Richard Wurtman invented the supplement mixture, known as Souvenaid, which appears to stimulate growth of new synapses.

**2012** Researchers, including Young Lee and PhD graduate Tianheng Han, have followed up on earlier theoretical predictions and demonstrated experimentally the existence of a fundamentally new magnetic state called a quantum spin liquid (QSL), adding to the two previously known states of magnetism. The QSL is a solid crystal, but its magnetic state is described as liquid: Unlike the other two kinds of magnetism, the magnetic orientations of the individual particles within it fluctuate constantly, resembling the constant motion of molecules within a true liquid.

**2013** A new steelmaking process developed by MIT researchers, Donald Sadoway, Antoine Allanore, and former postdoc Lan Yin, produces no emissions other than pure oxygen and carries nice side benefits: The resulting steel should be of higher purity, and eventually, once the process is scaled up, cheaper.

**2013** A research team, led by Yuriy Román, has devised a cheaper way to synthesize a key biofuel component, which could make its industrial production much more cost-effective. The compound, known as gamma-valerolactone (GVL), has more energy than ethanol and could be used on its own or as an additive to other fuels. GVL could also be useful as a “green” solvent or a building block for creating renewable polymers from sustainable materials.
2013 A system being developed by Dina Katabi and her graduate student Fadel Adib, could give us the ability to see people through walls using low-cost Wi-Fi technology. The system, called “Wi-Vi,” is based on a concept similar to radar and sonar imaging. But in contrast to radar and sonar, it transmits a low-power Wi-Fi signal and uses its reflections to track moving humans.

2013 Hydrophobic materials—water-shedding surfaces—have a theoretical limit on the time it takes for a water droplet to bounce away from such a surface. Researchers, led by Kripa Varanasi, have found a way to burst through that perceived barrier, reducing the contact time by at least 40 percent. This research could aid ice prevention, wing efficiency, and more.

2014 Platinum-group metals can be considered unsustainable resources that are needed catalysts to enable renewable energy technologies. Graduate student Sean Hunt, postdoc Tarit Nimmandwudipong, and Yuriy Román have devised a process of synthesizing renewable alternative catalysts.

2014 Engineers at MIT and Lawrence Livermore National Laboratory (LLNL) have devised a way to translate that airy, yet remarkably strong, structure style of the Eiffel Tower down to the microscale—designing a system that could be fabricated from a variety of materials, such as metals or polymers, and that may set new records for stiffness for a given weight. Nicholas Fang; former postdoc Howon Lee, visiting research fellow Qi “Kevin” Ge; LLNL’s Christopher Spadaccini and Xiaoyu “Rayne” Zheng are among the researchers involved in the project.

2014 Researchers at MIT, including Gang Chen and postdoc Hadi Ghasemi, have developed a new material structure—a layer of graphite flakes and an underlying carbon foam—that generates steam by soaking up the sun. The material is able to convert 85 percent of incoming solar energy into steam—a significant improvement over recent approaches to solar-powered steam generation. The setup loses very little heat in the process, and can produce steam at relatively low solar intensity.

2014 Bryan Hsu PhD ’14 and Paula Hammond, working with Myoung-Hwan Park of Shamyouk University in South Korea and Samantha Hagerman ’14, have developed a new drug-delivery system method that could enable pain medication and other drugs to be released directly to specific parts of the body. The method uses biodegradable, nanoscale “thin films” laden with drug molecules that are absorbed into the body in steady doses over a period of up to 14 months.

2014 Researchers at MIT, including John Foster, the University of Colorado, including Daniel Baker, and elsewhere have found there’s a hard limit to how close ultrarelativistic electrons can get to the Earth. The team found that no matter where these electrons are circling around the planet’s equator, they can get no further than about 11,000 kilometers from the Earth’s surface—despite their intense energy. See page 62 for more information.

2015 Natalie Artzi and Elazer Edelman, working with other researchers, found that a tissue adhesive they had previously developed worked much differently in cancerous colon tissue than in colon tissue inflamed with colitis. The finding suggests that for this sealant or any other kind of biomaterial designed to work inside the human body, scientists must take into account the environment in which the material will be used, instead of using a “one-size fits all” approach. See page 60 for more information.

2015 Kimberly Hamad-Schifferli and Lee Gehrke are among the researchers that have devised a new diagnostic test that is a simple paper strip similar to a pregnancy test, that can rapidly diagnose Ebola, as well as other viral hemorrhagic fevers such as yellow fever and dengue fever. Unlike most existing paper diagnostics, which test for only one disease, the new MIT strips are color-coded so they can be used to distinguish among several diseases. See page 60 for more information.

2015 Research conducted by Polina Anikeeva, graduate student Ritchie Chen, postdoc Gabriela Romero, graduate student Michael Christiansen, and undergraduate Alan Mohr has developed a method to stimulate brain tissue using external magnetic fields and injected magnetic nanoparticles—a technique allowing direct stimulation of neurons, which could be an effective treatment for a variety of neurological diseases, without the need for implants or external connections. See page 56 for more information.
Faculty and Staff
MIT employs 11,843 persons on campus. In addition to the faculty, there are research, library, and administrative staff, and many others who, directly or indirectly, support the teaching and research goals of the Institute.

Faculty and Staff, 2014–2015

<table>
<thead>
<tr>
<th>Employee Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>1,021</td>
</tr>
<tr>
<td>Other academic and instructional staff</td>
<td>1,003</td>
</tr>
<tr>
<td>Research staff and research scientists (includes postdoctoral positions)</td>
<td>3,289</td>
</tr>
<tr>
<td>Administrative staff</td>
<td>2,886</td>
</tr>
<tr>
<td>Support staff</td>
<td>1,538</td>
</tr>
<tr>
<td>Service staff</td>
<td>812</td>
</tr>
<tr>
<td>Clinical and Medical staff</td>
<td>104</td>
</tr>
<tr>
<td>Affiliated faculty, scientists, and scholars</td>
<td>1,190</td>
</tr>
<tr>
<td><strong>Total campus faculty and staff</strong></td>
<td>11,843</td>
</tr>
</tbody>
</table>

Faculty
The MIT faculty instruct undergraduate and graduate students, and engage in research and service.

Faculty Profile, 2014–2015

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors</td>
<td>662</td>
<td>65</td>
</tr>
<tr>
<td>Associate professors</td>
<td>190</td>
<td>19</td>
</tr>
<tr>
<td>Assistant professors</td>
<td>169</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,021</td>
<td>100</td>
</tr>
<tr>
<td>Male</td>
<td>796</td>
<td>78</td>
</tr>
<tr>
<td>Female</td>
<td>225</td>
<td>22</td>
</tr>
</tbody>
</table>

See page 40 for a chart of faculty and students from 1865–2015.

Seventy-six percent of faculty are tenured.

Faculty may hold dual appointments where they are appointed equally to two departments. Thirty faculty members have dual appointments.

Faculty by School, 2014–2015

<table>
<thead>
<tr>
<th>School</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>78</td>
<td>8</td>
</tr>
<tr>
<td>Engineering</td>
<td>378</td>
<td>37</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>167</td>
<td>16</td>
</tr>
<tr>
<td>Science</td>
<td>274</td>
<td>27</td>
</tr>
<tr>
<td>Management</td>
<td>113</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,021</td>
<td>100</td>
</tr>
</tbody>
</table>

Sixty-four percent of the faculty are in science and engineering fields.

Each year, MIT employs about 1,160 graduate students as teaching assistants and 3,600 graduate students as research assistants.

MIT Lincoln Laboratory employs about 3,480 people, primarily at Hanscom Air Force Base in Lexington, Massachusetts. See page 84 for additional Lincoln Laboratory staffing information.
Twenty percent of faculty are members of a minority group; seven percent of faculty identify with an underrepresented minority group.

**Faculty by U.S. Minority Group, 2014–2015**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Female Count</th>
<th>Male Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>29</td>
<td>103</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>4</td>
<td>35</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Ethnicity is self-identified, and faculty members may identify with more than one group.

Forty-two percent of current faculty are internationally born. Over seventy countries are represented by these faculty members.

**Country of Origin of Internationally Born Faculty, 2014–2015**

- China: 9%
- India: 8%
- United Kingdom: 7%
- Canada: 7%
- Germany: 5%
- Greece: 5%
- Israel: 4%
- Italy: 4%
- South Korea: 3%
- Spain: 3%
- France: 4%
- Russia: 3%
- All others: 38%

**Elapsed Years at MIT of Faculty, 2014–2015**

(Excludes time as student)
Researchers
MIT campus research staff and scientists total 3,289. These researchers work with MIT faculty and students on projects funded by government, nonprofits and foundations, and industry.

### Campus Research Staff and Scientists, 2014–2015

<table>
<thead>
<tr>
<th>Employee Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Researchers</td>
<td>58</td>
</tr>
<tr>
<td>Principal Researchers</td>
<td>115</td>
</tr>
<tr>
<td>Research Scientists and Technicians</td>
<td>1,054</td>
</tr>
<tr>
<td>Visiting Scientists</td>
<td>499</td>
</tr>
<tr>
<td>Postdoctoral Associates</td>
<td>1,050</td>
</tr>
<tr>
<td>Postdoctoral Fellows</td>
<td>513</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,289</strong></td>
</tr>
</tbody>
</table>

In fall 2014, approximately 2,600 graduate students were research assistants.
Postdoctoral Scholars
As of October 31, 2014, MIT hosts 1,565 postdoctoral associates and fellows—415 females and 1,150 males. These individuals work with faculty in academic departments, laboratories, and centers.

U.S. Citizen and Permanent Resident Postdoctoral Scholars by Ethnicity, 2014–2015

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic or Latino</td>
<td>27</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>0</td>
</tr>
<tr>
<td>Total underrepresented minorities (URM)</td>
<td>35</td>
</tr>
<tr>
<td>White</td>
<td>264</td>
</tr>
<tr>
<td>Asian</td>
<td>69</td>
</tr>
<tr>
<td>Two or more races</td>
<td>7</td>
</tr>
<tr>
<td>Unknown</td>
<td>166</td>
</tr>
<tr>
<td>Total</td>
<td>541</td>
</tr>
</tbody>
</table>

International Postdoctoral Scholars
Top Countries of Citizenship, 2014–2015

<table>
<thead>
<tr>
<th>Country of Citizenship</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>196</td>
</tr>
<tr>
<td>India</td>
<td>83</td>
</tr>
<tr>
<td>South Korea</td>
<td>81</td>
</tr>
<tr>
<td>Germany</td>
<td>74</td>
</tr>
<tr>
<td>Canada</td>
<td>62</td>
</tr>
<tr>
<td>Israel</td>
<td>61</td>
</tr>
<tr>
<td>France</td>
<td>48</td>
</tr>
<tr>
<td>Italy</td>
<td>47</td>
</tr>
<tr>
<td>Iran</td>
<td>34</td>
</tr>
<tr>
<td>Spain</td>
<td>31</td>
</tr>
</tbody>
</table>

Ethnicity of Postdoctoral Scholars, 2014–2015

- International: 65%
- White: 17%
- Asian: 4%
- URM: 2%
- Two or more races: <1%
- Unknown: 11%

Years at MIT of Postdoctoral Scholars, 2014–2015

- Less than 1 year: 385
- 1 year: 250
- 2 years: 140
- 3 years: 125
- 4 years: 100
- 5 years: 75
- 6 years: 50

Postdoctoral scholars come from 76 foreign countries.
Awards and Honors of Current Faculty and Staff

Nobel Prize
Nine current faculty members at MIT have received the Nobel Prize. They are:

- H. Robert Horvitz  
  Nobel Prize in Physiology or Medicine (shared)
- Wolfgang Ketterle  
  Nobel Prize in Physics (shared)
- Robert C. Merton  
  Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (shared)
- Richard R. Schrock  
  Nobel Prize in Chemistry (shared)
- Phillip A. Sharp  
  Nobel Prize in Physiology or Medicine (shared)
- Susan Solomon  
  Nobel Peace Prize (co-chair of Working Group One recognized under Intergovernmental Panel on Climate Change (IPCC), shared)
- Samuel C. C. Ting  
  Nobel Prize in Physics (shared)
- Susumu Tonegawa  
  Nobel Prize in Physiology or Medicine
- Frank Wilczek  
  Nobel Prize in Physics (shared)

Number of recipients of selected awards and honors current faculty and staff have received

<table>
<thead>
<tr>
<th>Recipients</th>
<th>Award Name and Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>152</td>
<td>American Academy of Arts and Sciences Member</td>
</tr>
<tr>
<td>99</td>
<td>American Association for the Advancement of Science Fellow</td>
</tr>
<tr>
<td>12</td>
<td>American Philosophical Society Member</td>
</tr>
<tr>
<td>88</td>
<td>American Physical Society Fellow</td>
</tr>
<tr>
<td>22</td>
<td>American Society of Mechanical Engineers Fellow</td>
</tr>
<tr>
<td>29</td>
<td>Association for Computing Machinery Fellow</td>
</tr>
<tr>
<td>4</td>
<td>John Bates Clark Medal, American Economic Association</td>
</tr>
<tr>
<td>3</td>
<td>Dirac Medal, Abdus Salam International Centre for Theoretical Physics</td>
</tr>
<tr>
<td>9</td>
<td>Fulbright Scholar, Council for International Exchange of Scholars (CIES)</td>
</tr>
<tr>
<td>7</td>
<td>Gairdner Award, Gairdner Foundation</td>
</tr>
<tr>
<td>67</td>
<td>Guggenheim Fellow, John Simon Guggenheim Memorial Foundation</td>
</tr>
<tr>
<td>18</td>
<td>HHMI Investigator, Howard Hughes Medical Institute (HHMI)</td>
</tr>
<tr>
<td>55</td>
<td>Institute of Electrical and Electronics Engineers, Inc. Fellow</td>
</tr>
<tr>
<td>32</td>
<td>Institute of Medicine Member, National Academies</td>
</tr>
<tr>
<td>1</td>
<td>Japan Prize, Science and Technology Foundation of Japan</td>
</tr>
<tr>
<td>3</td>
<td>Kavli Prize, Norwegian Academy of Science and Letters</td>
</tr>
<tr>
<td>1</td>
<td>Kyoto Prize, Inamori Foundation of Japan</td>
</tr>
<tr>
<td>23</td>
<td>MacArthur Fellow, John D. and Catherine T. MacArthur Foundation</td>
</tr>
<tr>
<td>2</td>
<td>Millennium Technology Prize, Millennium Prize Foundation</td>
</tr>
<tr>
<td>68</td>
<td>National Academy of Engineering Member, National Academies</td>
</tr>
<tr>
<td>80</td>
<td>National Academy of Sciences Member, National Academies</td>
</tr>
<tr>
<td>11</td>
<td>National Medal of Science, National Science &amp; Technology Medals Foundation</td>
</tr>
<tr>
<td>1</td>
<td>National Medal of Technology and Innovation, National Science &amp; Technology Medals Foundation</td>
</tr>
<tr>
<td>2</td>
<td>Rolf Nevanlinna Prize, International Mathematical Union (IMU)</td>
</tr>
<tr>
<td>29</td>
<td>Presidential Early Career Awards for Scientists and Engineers (PECASE)</td>
</tr>
<tr>
<td>3</td>
<td>Pulitzer Prize, Pulitzer Board</td>
</tr>
<tr>
<td>2</td>
<td>Queen Elizabeth Prize for Engineering, The Queen Elizabeth Prize for Engineering Foundation</td>
</tr>
<tr>
<td>4</td>
<td>Royal Academy of Engineering Fellow, Royal Academy of Engineering</td>
</tr>
<tr>
<td>5</td>
<td>A. M. Turing Award, Association for Computing Machinery</td>
</tr>
<tr>
<td>1</td>
<td>Von Hippel Award, Materials Research Society</td>
</tr>
<tr>
<td>2</td>
<td>John von Neumann Medal, Institute of Electrical and Electronics Engineers, Inc.</td>
</tr>
<tr>
<td>4</td>
<td>Alan T. Waterman Award, National Science Foundation</td>
</tr>
<tr>
<td>3</td>
<td>Wolf Prize, Wolf Foundation</td>
</tr>
</tbody>
</table>
Award Highlights

**Michael Stonebraker**  
2015 A.M. Turing Award

Michael Stonebraker, a researcher at MIT’s Computer Science and Artificial Intelligence Laboratory (CSAIL) who has revolutionized the field of database management systems (DBMSs) and founded multiple successful database companies, has won the Association for Computing Machinery’s (ACM) A.M. Turing Award, often referred to as “the Nobel Prize of computing.” This year marks the first time that the Turing Award comes with a Google-funded $1 million prize.

http://newsoffice.mit.edu/2015/michael-stonebraker-wins-turing-award-0325

**Alan Guth**  
2014 Kavli Prize in Astrophysics

Alan Guth shares the 2014 Kavli Prize in Astrophysics with Andrei Linde of Stanford University and Alexei Starobinsky of the Landau Institute for Theoretical Physics in Russia. Together, they are cited by the Kavli Foundation “for pioneering the theory of cosmic inflation.” Guth proposed the theory of cosmic inflation in 1980. The theory describes a period of extremely rapid exponential expansion within the first infinitesimal fraction of a second of the universe’s existence. At the end of inflation, approximately 14 billion years ago, the universe was in an extremely hot, dense, and small state, at the beginning of the more leisurely phase of expansion described by the conventional “Big Bang” theory. The conventional theory explains what happened after the bang. The theory of cosmological inflation describes the mechanism that propelled the expansion of the universe in the first place. Supported by three decades of development, including contributions from Linde, Andreas Albrecht, and Paul Steinhardt, Guth’s theory is now widely accepted by physicists.

http://newsoffice.mit.edu/2014/alan-guth-shares-1-million-kavli-prize-astrophysics

**Robert Langer**  
2014 Kyoto Prize

Robert Langer, the David H. Koch Institute Professor at MIT, is one of three individuals who have been awarded the 2014 Kyoto Prize, Japan’s highest private award for global achievement, created by Japanese philanthropist Kazuo Inamori. Langer was cited as “a founder of the field of tissue engineering and creator of revolutionary drug delivery system (DDS) technologies.” His citation notes that “tissue engineering is indispensable for the implementation of regenerative medicine. Langer’s technique applies biodegradable polymer technologies to construct ‘scaffolds’ for cell growth, contributing to the regeneration of tissues and organs. He has also developed DDS technologies for the controlled release of proteins, nucleic acids, and other macromolecular drugs. He holds more than 800 patents and is actively involved in promoting the practical application of his discoveries as a leader in the interdisciplinary advancement of medicine and engineering.”

Section 2
Students

Undergraduate Students  41
Graduate Students       42
Degrees                 43
Alumni                  44
Undergraduate Financial Aid  45
Graduate Financial Aid   48
Students

The Institute’s fall 2014 student body of 11,319 is highly diverse. Students come from all 50 states, the District of Columbia, three territories and dependencies, and 116 foreign countries. The Institute’s 3,302 international students make up ten percent of the undergraduate population and 42 percent of the graduate population. See pages 106-108 for more information about international students.

### Student Profile, 2014–2015

<table>
<thead>
<tr>
<th>Student Level</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate</td>
<td>4,512</td>
<td>40</td>
</tr>
<tr>
<td>Graduate</td>
<td>6,807</td>
<td>60</td>
</tr>
<tr>
<td>Total</td>
<td>11,319</td>
<td>100</td>
</tr>
</tbody>
</table>

In fall 2014, 44 percent of MIT’s first-year students (who reported their class standing) were first in their high school class; 93 percent ranked in the top five percent.

### U.S. Citizen and Permanent Resident Student Minorities, 2014–2015

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Undergraduate Count</th>
<th>Graduate Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian American</td>
<td>1,228</td>
<td>851</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>722</td>
<td>365</td>
</tr>
<tr>
<td>African American</td>
<td>332</td>
<td>118</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>44</td>
<td>48</td>
</tr>
<tr>
<td>Native Hawaiian or Pacific Islander</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Students may identify with more than one race or choose not to identify with a group. Eighty-one undergraduates and 491 graduate students chose not to identify an ethnicity or race. These figures may not precisely reflect the population because they are self-reported.

Students who identified, at least in part, as a U.S. minority group totaled 3,697—51% of undergraduate and 20% of graduate students.

### Faculty and Students, 1865–2015

[Graph showing the number of students and faculty over the years from 1865 to 2015.]

MIT Briefing Book
**Undergraduate Students**

Students first enrolled at MIT in 1865. Twenty-seven students enrolled as undergraduate students that first year. In fall 2014, there were 4,512 undergraduate students.

**Undergraduate Students by Citizenship, 2014–2015**

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. citizen</td>
<td>3,814</td>
<td>85</td>
</tr>
<tr>
<td>U.S. permanent resident</td>
<td>232</td>
<td>5</td>
</tr>
<tr>
<td>International</td>
<td>466</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,512</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Undergraduate Students by School, 2014–2015**

<table>
<thead>
<tr>
<th>School</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>36</td>
</tr>
<tr>
<td>Engineering</td>
<td>2,447</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>101</td>
</tr>
<tr>
<td>Management</td>
<td>53</td>
</tr>
<tr>
<td>Science</td>
<td>784</td>
</tr>
<tr>
<td>Undesignated*</td>
<td>1,091</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,512</strong></td>
</tr>
</tbody>
</table>

*Undesignated comprises freshman who do not enroll in a major and undesignated sophomores.*
Graduate Students
Graduate students have outnumbered undergraduate students at MIT since 1980. In fall 2014, they comprised 60 percent of the student population with 6,807 students—2,912 master’s students (includes 168 non-matriculating) and 3,895 doctoral students.

Graduate Students by Citizenship, 2014–2015

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. citizen</td>
<td>3,694</td>
<td>54</td>
</tr>
<tr>
<td>U.S. permanent resident</td>
<td>277</td>
<td>4</td>
</tr>
<tr>
<td>International</td>
<td>2,836</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>6,807</td>
<td>100</td>
</tr>
</tbody>
</table>

Graduate Students by Gender, 2014–2015

Male
- Doctoral: 2,719
- Master’s: 1,917
Female
- Doctoral: 1,176
- Master’s: 995

Graduate Students by School, 2014–2015

<table>
<thead>
<tr>
<th>School</th>
<th>Master’s Count*</th>
<th>Doctoral Count</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>410</td>
<td>176</td>
<td>586</td>
</tr>
<tr>
<td>Engineering</td>
<td>1,022</td>
<td>2,121</td>
<td>3,143</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>28</td>
<td>297</td>
<td>325</td>
</tr>
<tr>
<td>Management</td>
<td>1,274</td>
<td>154</td>
<td>1,428</td>
</tr>
<tr>
<td>Science</td>
<td>10</td>
<td>1,147</td>
<td>1,157</td>
</tr>
<tr>
<td>Total</td>
<td>2,744</td>
<td>3,895</td>
<td>6,639</td>
</tr>
</tbody>
</table>

*Excludes non-matriculating students
**Degrees**


### Degrees Awarded by Type, 2013–2014

<table>
<thead>
<tr>
<th>Degree Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science degrees</td>
<td>1,060</td>
</tr>
<tr>
<td>Master of Science degrees</td>
<td>730</td>
</tr>
<tr>
<td>Master of Architecture, Master in City Planning, Master of Engineering, Master of Business Administration, and Master of Finance degrees</td>
<td>1,081</td>
</tr>
<tr>
<td>Engineer’s degrees</td>
<td>14</td>
</tr>
<tr>
<td>Doctoral degrees</td>
<td>594</td>
</tr>
</tbody>
</table>

### Degrees Awarded by School, 2013–2014

<table>
<thead>
<tr>
<th>School</th>
<th>Bachelor’s Count</th>
<th>Master’s and Engineer’s Count</th>
<th>Doctorate Count</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>17</td>
<td>188</td>
<td>33</td>
<td>238</td>
</tr>
<tr>
<td>Engineering</td>
<td>675</td>
<td>774</td>
<td>355</td>
<td>1,804</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>45</td>
<td>28</td>
<td>47</td>
<td>120</td>
</tr>
<tr>
<td>Management</td>
<td>34</td>
<td>815</td>
<td>19</td>
<td>868</td>
</tr>
<tr>
<td>Science</td>
<td>289</td>
<td>20</td>
<td>140</td>
<td>449</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,060</strong></td>
<td><strong>1,825</strong></td>
<td><strong>594</strong></td>
<td><strong>3,479</strong></td>
</tr>
</tbody>
</table>

### Degrees Awarded by Gender, 2013–2014

<table>
<thead>
<tr>
<th>Degree Type</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor’s</td>
<td>583</td>
<td>477</td>
<td>1,060</td>
</tr>
<tr>
<td>Master’s</td>
<td>570</td>
<td>443</td>
<td>1,013</td>
</tr>
<tr>
<td>Doctorate</td>
<td>433</td>
<td>161</td>
<td>594</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School</th>
<th>Bachelor’s</th>
<th>Master’s and Engineer’s</th>
<th>Doctorate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>477</td>
<td></td>
<td>161</td>
<td>638</td>
</tr>
<tr>
<td>Engineering</td>
<td>583</td>
<td></td>
<td>433</td>
<td>1,096</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>570</td>
<td></td>
<td>443</td>
<td>1,013</td>
</tr>
<tr>
<td>Management</td>
<td>443</td>
<td></td>
<td>161</td>
<td>604</td>
</tr>
<tr>
<td>Science</td>
<td>1,013</td>
<td></td>
<td>449</td>
<td>1,462</td>
</tr>
</tbody>
</table>
Alumni

Seventy-five percent of alumni respondents said they have enrolled in a graduate or professional degree program since graduating from MIT. Of those who have enrolled in a graduate or professional degree program, over half did so immediately upon graduation. This includes students who earned a graduate degree simultaneously with their bachelor’s degree. Eighty-five percent of respondents said they are employed either full-time or part-time. An additional 4% are unemployed and seeking employment. The remainder is either on leave or unemployed and not currently seeking employment. Among those respondents who are employed, 64% work in the for-profit sector, 13% work in government or military agencies, 14% work in the nonprofit sector, and 9% are self-employed. Twenty-two percent of respondents reported having started a company. Fourteen percent said they are currently developing a start-up company.

Service is a part of the lives of our alumni. Eighty-seven percent of respondents have served as an officer or on a committee for a local club, organization, or place of worship in the last 10 years. Thirty-seven percent have been a board member for a nonprofit organization. Seventy-three percent have done volunteer work at least once in the last year.

A fall 2012 survey of graduate alumni (http://web.mit.edu/ir/surveys/grad_alum.html) revealed that 93% of respondents are employed, with just 2% seeking employment (others are engaged in such activities as travel and caring for family). The average annual salary was reported to be $156,793; the median was $137,500. Graduate alumni, overall, were most likely to report working in a private for-profit organization (54%), in a U.S. four-year college or university (13%), or to be self-employed (9%). 3.8% were employed by the U.S. federal government; 0.4% by U.S. state government; and 0.7% in U.S. local government. A spirit of entrepreneurship flourishes, as 28% of all surveyed graduate alumni have started a company. Among doctoral alumni, 41% have at least one patent or invention.

MIT’s 130,431 living alumni are connected to the Institute through graduating-class events, departmental organizations, and over 47 clubs in the United States and 42 abroad. More than 12,000 volunteers offer their time, financial support, and service on committees and on the MIT Corporation, the Institute’s Board of Trustees. MIT graduates hold leadership positions in industries and organizations around the world. Over 21,000 alumni reside in Massachusetts, and about 86 percent of MIT’s alumni live in the United States.
**Undergraduate Financial Aid**

**Principles of MIT Undergraduate Financial Aid**

To ensure that MIT remains accessible to all qualified students regardless of their financial resources, MIT is committed to three guiding financial aid principles:

- **Need-blind admissions**: MIT recruits and enrolls the most talented and promising students without regard to their financial circumstances.

- **Meeting the full need**: MIT guarantees that each student’s demonstrated financial need is fully met.

As a result of these guiding principles, the Institute significantly discounts tuition.

---

**Net Undergraduate Tuition and Fees as a Percentage of Total Tuition and Fees***

*Net tuition and fees calculated as a percentage of gross undergraduate tuition and fees received, minus MIT undergraduate scholarships.*
**Who Pays for an MIT Undergraduate Education**

In 2013–2014, the annual price of an MIT education totaled $59,520 per student—$43,498 for tuition and fees, $12,744 for room and board, an estimated $2,778 for books, supplies, and personal expenses, and a per-student average of $500 for travel. With 4,510 undergraduates enrolled, the collective price for undergraduates was $268.4 million. Of this amount, families paid $142.7 million, or 53 percent, and financial aid covered the remaining 47 percent, or $125.7 million. Since MIT subsidizes the cost of educating undergraduates through its tuition pricing and continues to be the largest source of financial aid to its undergraduates, the Institute is the primary source for paying for an MIT undergraduate education, and families the secondary source.

**Forms of Financial Undergraduate Aid**

The primary form of financial aid to MIT undergraduates is grants or scholarships—terms that are used interchangeably, although grants are gift aid based on need and scholarships are gift aid based on merit. Since 2005–2006 the share of undergraduate aid in the form of grants/scholarships rose from 80.9 to 85.1 percent while the share in the form of student loans fell from 11.1 to 7.3 percent and term-time work decreased from 8.0 to 7.6 percent.

From the students’ perspective, grants are the sole form of aid that unambiguously increases the financial accessibility of college, since they don’t require repayment and don’t increase the students’ indebtedness. The preponderance of grant aid at MIT sets the Institute apart from the national trend toward student loans as the primary form of undergraduate financial aid.


<table>
<thead>
<tr>
<th>Aid Type</th>
<th>Amount (in U.S. Dollars)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grants and Scholarships</td>
<td>107,035,530</td>
<td>85</td>
</tr>
<tr>
<td>Student Loans</td>
<td>9,192,991</td>
<td>7</td>
</tr>
<tr>
<td>Term-time employment</td>
<td>9,511,475</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>125,739,996</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Sources of Undergraduate Financial Aid

In 2013–2014, MIT provided 75.9 percent of undergraduate financial aid. The federal government provided 13.1 percent, and the remaining 11 percent came from state and private resources. MIT also differs here from the national trend of relying on the federal government as the largest source of financial aid.

Approximately 56 percent of MIT undergraduates received an MIT grant, averaging $34,551 each. These grants come primarily from MIT’s endowed funds, gifts from alumni and friends, and general Institute funds.

MIT participates in the Federal Pell Grant Program, the Federal Direct Loan Program and the three campus-based programs: the Federal Supplemental Educational Opportunity Grant, the Federal Perkins Loan Program, and the Federal Work-Study Program. Approximately 18 percent of MIT undergraduates receive a Pell Grant. MIT has participated in these programs since their inception and values their role in making an MIT education accessible to all qualified students. In addition, MIT undergraduates receive federal aid for their participation in the Air Force, Army, and Navy ROTC. ROTC aid is not based on need.

Students receive private scholarships in recognition of their academic accomplishments, athletic or musical skills, career interests, and many other criteria. Several states, in addition to Massachusetts, allow their residents to receive a state grant while attending MIT. These states include Connecticut, Pennsylvania, Rhode Island and Vermont. Most state grants are need-based.

The following table summarizes the sources and types of financial aid MIT undergraduates received in 2013–2014.

### Sources of Financial Aid for MIT Undergraduates, 2013–2014

<table>
<thead>
<tr>
<th>Aid Source</th>
<th>Amount (in U.S. Dollars)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT Financial Aid</td>
<td>95,385,277</td>
<td>76</td>
</tr>
<tr>
<td>Federal Financial Aid</td>
<td>16,411,772</td>
<td>13</td>
</tr>
<tr>
<td>State Financial Aid</td>
<td>195,018</td>
<td>0</td>
</tr>
<tr>
<td>Private Financial Aid</td>
<td>13,747,929</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>125,739,996</td>
<td>100</td>
</tr>
</tbody>
</table>

*The total column and row are unduplicated numbers of students.*

### Undergraduate Financial Aid, 2013–2014

<table>
<thead>
<tr>
<th>Source</th>
<th>Scholarships/Grants</th>
<th>Loans</th>
<th>Employment</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount ($)</td>
<td>Students</td>
<td>Amount ($)</td>
<td>Students</td>
</tr>
<tr>
<td>MIT</td>
<td>87,931,906</td>
<td>2,545</td>
<td>290,938</td>
<td>86</td>
</tr>
<tr>
<td>Federal</td>
<td>7,492,877</td>
<td>878</td>
<td>6,569,853</td>
<td>878</td>
</tr>
<tr>
<td>State</td>
<td>195,018</td>
<td>96</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Private</td>
<td>11,415,729</td>
<td>1,337</td>
<td>2,332,200</td>
<td>107</td>
</tr>
<tr>
<td>Total*</td>
<td>107,035,530</td>
<td>3,187</td>
<td>9,192,991</td>
<td>993</td>
</tr>
</tbody>
</table>
Graduate Financial Aid
Principles of MIT Graduate Financial Aid
MIT makes financial support available to graduate students from a variety of sources and in several different forms. Many forms of support are granted solely on the basis of merit (teaching and research assistantships; on-campus employment; some fellowships, scholarships, and traineeships), while others are granted on the basis of financial need (federal loans; some fellowships, scholarships, and traineeships; on-campus employment) or a combination of merit and need (some fellowships, scholarships, and traineeships; on-campus employment).

Tuition support, in particular, is provided to graduate and professional students in connection with research assistantships, teaching assistantships, and fellowship appointments. Tuition revenue support from MIT funds is considered financial aid but is not included in this report, as no singular office administers these sources of support.

A typical financial support package for a graduate student includes tuition, health insurance, and stipend support. The largest part of an MIT graduate student’s expenses is dedicated to tuition ($43,210 for the 2013–2014 academic year). Another portion ($2,088) is dedicated to health insurance, unless a student already has comparable coverage. General living costs, including housing, food, transportation, and books, are largely covered by a stipend (approximately $31,969 for a doctoral student). Approximately 95% of doctoral students are fully funded for the duration of their program. MIT houses approximately 40% of the graduate student body on campus, which contributes to keeping average housing costs at a reasonable level for graduate students within the context of the Boston area. The graduate residences also help foster a thriving on-campus graduate community that many graduate students cite as one of the most positive aspects of their time here.

How Graduate Students are Supported
Enrollment is determined at the department and program level and departments and programs admit as many students as they can support based on their RA, TA, and fellowship resources as well as the number of faculty available to advise on research.
Students

Forms of Graduate Financial Aid

Fellowships, Traineeships, and Scholarships

At MIT, fellowships and traineeships differ from scholarships. A fellowship award to a graduate student covers full or partial tuition, and also provides a stipend to help defray living expenses. In the context of graduate study, a scholarship covers full or partial tuition only. Although most awards are made on the basis of academic merit, financial need is a factor in some instances. Recipients of graduate financial aid must be enrolled as regular resident students. The Institute annually receives funds from individual and corporate donors for the support of fellowships and scholarships. In addition, government agencies and private foundations provide grants and fellowships—often directly to outstanding students—for use at institutions of the student’s choice. But occasionally these funds are directed to MIT for Institute designation of recipients.

For the fall semester 2013, the breakdown of funding sources for students that were primarily supported by fellowships was as follows:

<table>
<thead>
<tr>
<th>Sponsor</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Defense</td>
<td>89</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>20</td>
</tr>
<tr>
<td>NIH and HHS</td>
<td>35</td>
</tr>
<tr>
<td>NASA</td>
<td>18</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>317</td>
</tr>
<tr>
<td>Other Federal Agencies</td>
<td>4</td>
</tr>
<tr>
<td>Other US sources</td>
<td>124</td>
</tr>
<tr>
<td>Non-US sources</td>
<td>115</td>
</tr>
<tr>
<td>MIT Internal</td>
<td>1,163</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,885</strong></td>
</tr>
</tbody>
</table>

Teaching Assistantships

MIT employs about 1,160 graduate students each year as part-time or full-time teaching assistants to assist the faculty in grading, instructing in the classroom and laboratory, and conducting tutorials. Teaching assistants receive stipends as well as tuition support for the services that they provide.

Research Assistantships

Each year, about 3,600 graduate students at MIT hold appointments as research assistants. The principal duty of a research assistant is to contribute to a program of departmental or interdepartmental research. Research assistants receive stipends as well as tuition support for the services that they provide, and are compensated on the basis of time devoted to their research.

Students who receive financial support from other sources (fellowships, scholarships, etc.) may receive supplementary stipends as teaching or research assistants in accordance with Institute and departmental guidelines.

Self-Support

Graduate and professional students are eligible for need-based financial aid, including student loans, as well as student employment under the Federal Work-Study Program, both of which are administered and reported by MIT Student Financial Services (SFS). Graduate student employment earnings under the Federal Work-Study Program, including on- and off-campus programs, totaled $1.4 million in 2013–2014, with 1.4 percent of graduate and professional students (91 students) earning $15,006 on average.

In AY2014, graduate students borrowed loans that totaled $44.9 million, a decrease of approximately $1.3 million from the prior year, with 12.4 percent of graduate and professional students (819 students) borrowing an average of $54,816.
Section 3
Campus Research

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  NASA 62
  National Science Foundation 64
  Other Federal Agencies 66
  Nonprofit Organizations 68
Research Support
MIT has historically viewed teaching and research as inseparable parts of its academic mission. Therefore, the Institute recognizes its obligation to encourage faculty to pursue research activities that hold the greatest promise for intellectual advancement. MIT maintains one of the most vigorous programs of research of any university and conducts basic and applied research principally at two Massachusetts locations, the MIT campus in Cambridge and MIT Lincoln Laboratory, a federally funded research and development center in Lexington.

MIT pioneered the federal/university research relationship, starting in World War II. Initially called upon by the federal government to serve the national war effort, that relationship has continued into the present day, helping MIT fulfill its original mission of serving the nation and the world.

Research Expenditures (MIT FY2014)

Cambridge campus $678.4 million
Lincoln Laboratory* $811.3 million
SMART* $31.6 million
Total $1,521.3 million

*Totals do not include research performed by campus laboratories for Lincoln Laboratory and Singapore-MIT Alliance for Research and Technology (SMART).

All federal research on campus is awarded competitively based on the scientific and technical merit of the proposals. In FY2014, there were 2,601 active awards and 389 members of research consortiums.

Research activities range from individual projects to large-scale, collaborative, and sometimes international endeavors. Peer-reviewed research accomplishments form a basis for reviewing the qualifications of prospective faculty appointees and for evaluations related to promotion and tenure decisions.

†SMART: Singapore-MIT Alliance for Research and Technology
‡Total Research constant dollars are calculated using the Consumer Price Index for all Urban Consumers weighted with fiscal year 2014 equaling 100.
The Institute provides the faculty with the infrastructure and support necessary to conduct research, much of it through contracts, grants, and other arrangements with government, industry, and foundations. The Office of Sponsored Programs provides central support related to the administration of sponsored research programs, and it assists faculty, other principal investigators, and their local administrators in managing and identifying resources for individual sponsored projects. In addition, a Research Council—which is chaired by the Vice President for Research and composed of the heads of all major research laboratories and centers that report to the Vice President for Research—addresses research policy and administration issues.

The Resource Development Office is available to work with faculty to generate proposals for foundation or other private support.

The Institute sees profound merit in a policy of open research and free interchange of information among scholars. At the same time, MIT is committed to acting responsibly and ethically in all its research activities. As a result, MIT has policies related to the suitability of research projects, research conduct, sources of support, use of human subjects, sponsored programs, relations with intelligence agencies, the acquisition of art and artifacts, the disposition of equipment, and collaborations with research-oriented industrial organizations. These policies are spelled out on the Policies and Procedures website and on the Office of Sponsored Programs website.

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**Campus Research Expenditures and Faculty Excluding Broad and Defense Labs 1940–2014**

DAPER: Department of Athletics, Physical Education and Recreation

DSL: Division of Student Life
**Campus Research Sponsors**

The tables and charts for campus research expenditures below, and on the following pages, show the amount MIT expended by fiscal year (July 1–June 30). These figures do not include expenditures for MIT Lincoln Laboratory. Information for Lincoln Laboratory begins on page 71. Expenditures funded by industrial sponsors are shown on page 91 in the MIT and Industry section. Federal research expenditures include all primary contracts and grants, including sub-awards from other organizations where the federal government is the original funding source.

### Campus Research Expenditures (in U.S. Dollars)

#### Fiscal Years 2005–2014

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>374,103,793</td>
<td>382,784,774</td>
<td>373,603,371</td>
<td>369,008,780</td>
<td>381,459,466</td>
</tr>
<tr>
<td>Non-federal</td>
<td>110,675,892</td>
<td>114,361,780</td>
<td>114,389,201</td>
<td>132,487,316</td>
<td>158,595,887</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>484,779,685</strong></td>
<td><strong>497,146,554</strong></td>
<td><strong>487,992,571</strong></td>
<td><strong>501,496,096</strong></td>
<td><strong>540,055,353</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>430,154,479</td>
<td>469,520,579</td>
<td>472,582,743</td>
<td>465,946,679</td>
<td>454,938,599</td>
</tr>
<tr>
<td>Non-federal</td>
<td>184,216,417</td>
<td>191,304,692</td>
<td>208,496,567</td>
<td>208,401,668</td>
<td>223,473,071</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>614,370,896</strong></td>
<td><strong>660,825,271</strong></td>
<td><strong>681,079,310</strong></td>
<td><strong>674,348,348</strong></td>
<td><strong>678,411,670</strong></td>
</tr>
</tbody>
</table>

*Constant dollars* are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.

†National Institutes of Health data includes expenditures from other Department of Health and Human Services agencies which account for less than 1% of expenditures per year.
Campus Research Expenditures by Primary Sponsor

<table>
<thead>
<tr>
<th>Primary Sponsor</th>
<th>FY2014 (in U.S. Dollars)</th>
<th>Percent of Campus Total†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Defense</td>
<td>122,761,059</td>
<td>18</td>
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<td><strong>Total Non-Federal</strong></td>
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<td>Campus Total</td>
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*National Institutes of Health data includes expenditures from other Department of Health and Human Services agencies which account for less than 1% of expenditures per year.

†Percentages may not total due to rounding.
Department of Defense
Selected Projects

Magnetic brain stimulation
Researchers at MIT have developed a method to stimulate brain tissue using external magnetic fields and injected magnetic nanoparticles—a technique allowing direct stimulation of neurons, which could be an effective treatment for a variety of neurological diseases, without the need for implants or external connections.

In their study, the team injected magnetic iron oxide particles just 22 nanometers in diameter into the brain. When exposed to an external alternating magnetic field—which can penetrate deep inside biological tissues—these particles rapidly heat up. The resulting local temperature increase can then lead to neural activation by triggering heat-sensitive capsaicin receptors. The new work has proven that the approach is feasible, but much work remains to turn this proof-of-concept into a practical method for brain research or clinical treatment.

The research, conducted by Polina Anikeeva, graduate student Ritchie Chen, postdoc Gabriela Romero, graduate student Michael Christiansen, and undergraduate Alan Mohr, has been published in the journal *Science*. The work was funded by the Defense Advanced Research Projects Agency, MIT's McGovern Institute for Brain Research, and the National Science Foundation.

http://newsoffice.mit.edu/2015/magnetic-brain-stimulation-0312

A mollusk of a different stripe
The blue-rayed limpet is a tiny mollusk that lives in kelp beds along the coasts of Norway, Iceland, the United Kingdom, Portugal, and the Canary Islands. These diminutive organisms—as small as a fingernail—might escape notice entirely, if not for a very conspicuous feature: bright blue dotted lines that run in parallel along the length of their translucent shells.

Scientists at MIT and Harvard University have identified two optical structures within the limpet’s shell that give its blue-striped appearance. The structures are configured to reflect blue light while absorbing all other wavelengths of incoming light. The researchers speculate that such patterning may have evolved to protect the limpet, as the blue lines resemble the color displays on the shells of more poisonous soft-bodied snails.

The findings, reported in the journal *Nature Communications*, represent the first evidence of an organism using mineralized structural components to produce optical displays. While birds, butterflies, and beetles can display brilliant blues, among other colors, they do so with organic structures, such as feathers, scales, and plates. The limpet, by contrast, produces its blue stripes through an interplay of inorganic, mineral structures, arranged in such a way as to reflect only blue light.

The researchers say such natural optical structures may serve as a design guide for engineering color-selective, controllable, transparent displays that require no internal light source and could be incorporated into windows and glasses.

The researchers included Mathias Kolle, Ling Li and Christine Ortiz at MIT and James Weaver and Joanna Aizenberg at Harvard. This research was funded in part by the Air Force Office of Scientific Research, the National Science Foundation, and the Alexander von Humboldt Foundation.

http://newsoffice.mit.edu/2015/optical-structures-in-limpet-shell-0226

Detecting gases wirelessly and cheaply
MIT chemists have devised a new way to wirelessly detect hazardous gases and environmental pollutants, using a simple sensor that can be read by a smartphone. These inexpensive sensors could be widely deployed, making it easier to monitor public spaces or detect food spoilage in warehouses. Using this system, the researchers have demonstrated that they can detect gaseous ammonia, hydrogen peroxide, and cyclohexanone, among other gases.

Timothy Swager is the senior author of a paper describing the new sensors in the Proceedings of the National Academy of Sciences. Graduate student Joseph Azzarelli is the paper’s lead author; other authors are postdoc Katherine Mirica and former postdoc Jens Ravnsbaek.

The research was funded by the U.S. Army Research Laboratory and the U.S. Army Research Office through the MIT Institute for Soldier Nanotechnologies; the MIT Deshpande Center for Technological Innovation; and the National Cancer Institute.

http://newsoffice.mit.edu/2014/wireless-chemical-sensor-for-smartphone-1208
Campus Research

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2014
(shown in descending order of expenditures)

Research Laboratory of Electronics
Computer Science and Artificial Intelligence Laboratory
Biological Engineering
Institute for Soldier Nanotechnologies
Mechanical Engineering
Sociotechnical Systems Research Center
Microsystems Technology Laboratories
Lab for Information & Decision Systems
Aeronautics and Astronautics
Media Laboratory

In fall 2014, the Department of Defense funded the primary appointments of graduate students with 291 research assistantships and 89 fellowships.

Twenty-eight current faculty and staff have received the Office of Naval Research Young Investigator Program Award.

Department of Defense Campus Research Expenditures (in U.S. Dollars)
Fiscal Years 2010–2014

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<th>2010</th>
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<td>122,761,059</td>
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</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.
Unconventional photoconduction in an atomically thin semiconductor

It’s a well-known phenomenon in electronics: Shining light on a semiconductor, such as the silicon used in computer chips and solar cells, will make it more conductive. But now researchers have discovered that in a special semiconductor, light can have the opposite effect, making the material less conductive instead.

The phenomenon was discovered in an exotic two-dimensional semiconductor—a single layer of molybdenum disulfide (MoS₂) just three atoms thick. The finding is reported in a paper in *Physical Review Letters* by postdoc Joshua Lui; Nuh Gedik; and six others at MIT, Harvard University, and in Taiwan.

When a semiconductor is illuminated by light, its conductivity tends to increase. The MIT team, however, observed the opposite behavior in a two-dimensional semiconductor. The researchers found that when illuminated by intense laser pulses, single-layer MoS₂ is reduced to approximately one-third of its initial conductivity.

Lui says “One remarkable property of these materials is the strong confinement of charge carriers in a two-dimensional plane. ... As a consequence, the electrostatic interactions between the charge carriers are much stronger than those in three-dimensional solids.”

Gedik says that the work “might help us to realize room-temperature excitonic devices,” which would otherwise require extremely low temperatures. In addition, because the effect can be switched on and off using light pulses, such devices could be easy to control without wired connections.

The research was supported by the U.S. Department of Energy and the National Science Foundation.

http://newsoffice.mit.edu/2014/light-makes-semiconductor-less-conductive-1007
Leading Departments, Laboratories, and Centers
Receiving Support in Fiscal Year 2014
(shown in descending order of expenditures)

Plasma Science and Fusion Center
Laboratory for Nuclear Science
Materials Processing Center
Research Laboratory of Electronics
Mechanical Engineering
Chemical Engineering
Nuclear Science and Engineering
Nuclear Reactor Laboratory
Materials Science and Engineering
Computer Science and Artificial Intelligence Laboratory

In fall 2014, the Department of Energy funded the primary appointments of graduate students with 191 research assistantships and 22 fellowships.

Twenty-three current faculty and staff have received the Department of Energy Outstanding Junior Investigator award or Early Career Research Program Award.

Department of Energy Campus Research Expenditures (in U.S. Dollars)
Fiscal Years 2010–2014

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<td>88,450,656</td>
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*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.
Quick test for Ebola

When diagnosing a case of Ebola, time is of the essence. However, existing diagnostic tests take at least a day or two to yield results, preventing health care workers from quickly determining whether a patient needs immediate treatment and isolation.

A new test from MIT researchers could change that: The device, a simple paper strip similar to a pregnancy test, can rapidly diagnose Ebola, as well as other viral hemorrhagic fevers such as yellow fever and dengue fever.

The new device relies on lateral flow technology, which is used in pregnancy tests and has recently been exploited for diagnosing strep throat and other bacterial infections. Unlike most existing paper diagnostics, which test for only one disease, the new MIT strips are color-coded so they can be used to distinguish among several diseases. To achieve that, the researchers used triangular nanoparticles, made of silver, that can take on different colors depending on their size. This type of device could also be customized to detect other viral hemorrhagic fevers or other infectious diseases, by linking the silver nanoparticles to different antibodies.

Kimberly Hamad-Schifferli and Lee Gehrke are the senior authors of a paper describing the new device in the journal *Lab on a Chip*. The paper’s lead author is postdoc Chun-Wan Yen, and other authors are graduate student Helena de Puig, postdoc Justina Tam, instructor Jose Gomez-Marquez, and visiting scientist Irene Bosch. The research was funded by the National Institute of Allergy and Infectious Disease.

http://newsoffice.mit.edu/2015/ten-minute-ebola-test-0224

MIT researchers design tailored tissue adhesives

After undergoing surgery to remove diseased sections of the colon, up to 30 percent of patients experience leakage from their sutures, which can cause life-threatening complications. Many efforts are under way to create new tissue glues that can help seal surgical incisions and prevent such complications; now, a new study from MIT reveals that the effectiveness of such glues hinges on the state of the tissue in which they are being used.

The researchers found that a sealant they had previously developed worked much differently in cancerous colon tissue than in colon tissue inflamed with colitis. The finding suggests that for this sealant or any other kind of biomaterial designed to work inside the human body, scientists must take into account the environment in which the material will be used, instead of using a “one-size fits all” approach, according to the researchers.

The tissue glue works through a system where molecules in the adhesive serve as “keys” that interact with “locks”—chemical structures called amines found in abundance in structural tissue known as collagen. When enough of these locks and keys bind to each other, the adhesive forms a tight seal. This system is disrupted in colitic tissue because the inflammation breaks down collagen. The more severe the inflammation, the less adhesion occurs. However, cancerous tissue tends to have excess collagen, so the adhesive ends up working better than in healthy tissue.

Using this data, the researchers created a model to help them alter the composition of the material depending on the circumstances. By changing the materials’ molecular weight, the researchers can tune it to perform best in different types and states of tissue.

Natalie Artzi and Elazer Edelman are senior authors of a paper describing the findings in *Science Translational Medicine*. The paper’s lead authors are graduate student Nuria Oliva and former graduate student Maria Carcole. The research was funded by the National Institutes of Health and the MIT Deshpande Center for Technological Innovation.

http://newsoffice.mit.edu/2015/tailored-tissue-adhesives-0128
Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2014
(shown in descending order of expenditures)

Koch Institute for Integrative Cancer Research Biology
Biological Engineering
Chemistry
Picower Institute for Learning and Memory
McGovern Institute for Brain Research
Plasma Science and Fusion Center
Center for Environmental Health Sciences
Research Laboratory of Electronics
Institute for Medical Engineering and Science

In fall 2014, the National Institutes of Health and other Department of Health and Human Services programs funded the primary appointments of graduate students with 167 research assistantships and 32 fellowships.

Eleven current faculty or staff have received the NIH Director’s Pioneer Award. The recipients are Edward Boyden, Emery Brown, Arup Chakraborty, James Collins, Hidde Ploegh, Aviv Regev, Leona Samson, Alice Ting, Alexander van Oudenaarden, Mehmet Yanik, and Feng Zhang.
NASA
Selected Projects

A second minor planet may possess Saturn-like rings
There are only five bodies in our solar system that are known to bear rings. The planet Saturn; to a lesser extent, rings of gas and dust also encircle Jupiter, Uranus, and Neptune. The fifth member of this haloed group is Chariklo, one of a class of minor planets called centaurs: small, rocky bodies that possess qualities of both asteroids and comets.

Scientists only recently detected Chariklo’s ring system—a surprising finding, as it had been thought that centaurs are relatively dormant. Scientists at MIT and elsewhere have detected a possible ring system around a second centaur, Chiron.

The group observed a stellar occultation in which Chiron passed in front of a bright star. The researchers analyzed the star’s light emissions, and the momentary shadow created by Chiron, and identified optical features that suggest the centaur may possess a circulating disk of debris. The team believes the features may signify a ring system.

Amanda Bosh, Jessica Ruprecht, Michael Person, and Amanda Gulbis have published their results in the journal *Icarus*. This research was funded in part by NASA and the National Research Foundation of South Africa.


Plasma shield
High above Earth’s atmosphere, electrons whiz past at close to the speed of light. Such ultrarelativistic electrons, which make up the outer band of the Van Allen radiation belt, streak around the planet bombarding anything in their path. Exposure to such high-energy radiation can wreak havoc on satellite electronics, and pose serious health risks to astronauts.

Researchers at MIT, the University of Colorado, and elsewhere have found there’s a hard limit to how close ultrarelativistic electrons can get to the Earth. The team found that no matter where these electrons are circling around the planet’s equator, they can get no further than about 11,000 kilometers from the Earth’s surface—despite their intense energy.

What’s keeping this high-energy radiation at bay seems to be a phenomenon termed “plasmaspheric hiss”—very low-frequency electromagnetic waves in the Earth’s upper atmosphere. The researchers believe that plasmaspheric hiss essentially deflects incoming electrons, causing them to collide with neutral gas atoms in the Earth’s upper atmosphere, and ultimately disappear.

“It’s a very unusual, extraordinary, and pronounced phenomenon,” says John Foster, associate director of MIT’s Haystack Observatory. “What this tells us is if you parked a satellite or an orbiting space station with humans just inside this impenetrable barrier, you would expect them to have much longer lifetimes. That’s a good thing to know.”

Foster and his colleagues, including lead author Daniel Baker of the University of Colorado, have published their results in the journal *Nature*. This research was funded in part by NASA.


A twist on planetary origins
Meteors that have crashed to Earth have long been regarded as relics of the early solar system. These craggy chunks of metal and rock are studded with chondrules—tiny, glassy, spherical grains that were once molten droplets. Scientists have thought that chondrules represent early kernels of terrestrial planets: As the solar system started to coalesce, these molten droplets collided with bits of gas and dust to form larger planetary precursors.

Researchers at MIT and Purdue University have found that chondrules may have played less of a fundamental role. Based on computer simulations, the group concludes that chondrules were not building blocks, but rather byproducts of a violent and messy planetary process. Postdoc Brandon Johnson says the findings revise one of the earliest chapters of the solar system. Johnson and his colleagues, including Maria Zuber, have published their results in the journal *Nature*.

http://newsoffice.mit.edu/2015/meteorites-byproducts-of-planetary-formation-0114
Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2014
(shown in descending order of expenditures)

Kavli Institute for Astrophysics and Space Research
Earth, Atmospheric, and Planetary Sciences
Aeronautics and Astronautics
Haystack Observatory
Earth System Initiative
Center for Global Change Science
Research Laboratory of Electronics
Media Laboratory
Computer Science and Artificial Intelligence Laboratory
Mechanical Engineering

In fall 2014, NASA funded the primary appointments of graduate students with 53 research assistantships and 24 fellowships.
National Science Foundation
Selected Projects

New detector sniffs out origins of methane
Methane is a potent greenhouse gas, second only to carbon dioxide in its capacity to trap heat in Earth’s atmosphere for a long time. The gas can originate from lakes and swamps, natural-gas pipelines, deep-sea vents, and livestock. Understanding the sources of methane, and how the gas is formed, could give scientists a better understanding of its role in warming the planet.

A research team led by scientists at MIT and including colleagues from the Woods Hole Oceanographic Institution, the University of Toronto, and elsewhere has developed an instrument that can rapidly and precisely analyze samples of environmental methane to determine how the gas was formed.

The approach, called tunable infrared laser direct absorption spectroscopy, detects the ratio of methane isotopes, which can provide a “fingerprint” to differentiate between two common origins: microbial, in which microorganisms, typically living in wetlands or the guts of animals, produce methane as a metabolic byproduct; or thermogenic, in which organic matter, buried deep within the Earth, decays to methane at high temperatures.

Shuhei Ono and his colleagues, including first author and graduate student David Wang, publish their results in the journal Science. This research was funded in part by the National Science Foundation, Shell Oil, the Deep Carbon Observatory, the National Sciences and Engineering Research Council of Canada, and the German Research Foundation.

Morphable surfaces could cut air resistance
There is a story about how the modern golf ball came to be: In the mid-1800s, it is said, new golf balls were smooth, but became dimpled over time as impacts left permanent dents. Smooth new balls were typically used for tournament play, but in one match, a player ran short, had to use an old, dented one, and realized that he could drive this dimpled ball much further than a smooth one. Whether that story is true or not, testing over the years has proved that a golf ball’s irregular surface really does dramatically increase the distance it travels, because it can cut the drag caused by air resistance in half. Researchers at MIT are aiming to harness that same effect to reduce drag on a variety of surfaces—including domes that sometimes crumple in high winds, or perhaps even vehicles.

Detailed studies have shown that while a ball with a dimpled surface has half the drag of a smooth one at lower speeds, at higher speeds that advantage reverses. So the ideal would be a surface whose smoothness can be altered, literally, on the fly—and that’s what the MIT team has developed.

The work is described in a paper in the journal Advanced Materials by Pedro Reis and former post-docs Denis Terwagne and Miha Brojan. The research was supported by the National Science Foundation, MIT’s Charles E. Reed Faculty Initiatives Fund, the Wallonie-Bruxelles International, the Belgian American Education Foundation, and the Fulbright Foundation.
### National Science Foundation Campus Research Expenditures (in U.S. Dollars)
**Fiscal Years 2010–2014**

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<td>78,978,705</td>
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*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.

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**Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2014**

(Shown in descending order of expenditures)

- Computer Science and Artificial Intelligence Laboratory
- Research Laboratory of Electronics
- Earth, Atmospheric, and Planetary Sciences
- Kavli Institute for Astrophysics and Space Research
- Biological Engineering
- Mathematics
- Haystack Observatory
- Center for Materials Science and Engineering
- Mechanical Engineering
- Media Laboratory

In fall 2014, the National Science Foundation funded the primary appointments of graduate students with 287 research assistantships and 199 fellowships.

The National Science Foundation has awarded Faculty Early Career Development (CAREER) Awards to 158 current faculty and staff members.
The missing piece of the climate puzzle
In classrooms and everyday conversation, explanations of global warming hinge on the greenhouse gas effect. In short, climate depends on the balance between two different kinds of radiation: The Earth absorbs incoming visible light from the sun, called “shortwave radiation,” and emits infrared light, or “longwave radiation,” into space.

Upsetting that energy balance are rising levels of greenhouse gases, such as carbon dioxide (CO2), that increasingly absorb some of the outgoing longwave radiation and trap it in the atmosphere. Energy accumulates in the climate system, and warming occurs. In a paper in the *Proceedings of the National Academy of Sciences*, MIT researchers show that this view of global warming is only half the story.

In computer modeling of Earth’s climate under elevating CO2 concentrations, the greenhouse gas effect does indeed lead to global warming. While one would expect the longwave radiation that escapes into space to decline with increasing CO2, the amount actually begins to rise.

“The finding was a curiosity, conflicting with the basic understanding of global warming,” says lead author Aaron Donohoe, a former MIT postdoc who is now a research associate at the University of Washington’s Applied Physics Laboratory. Donohoe, along with MIT postdoc Kyle Armour and others at Washington found the answer by drawing on both computer simulations and an energy-balance model. As longwave radiation gets trapped by CO2, the Earth starts to warm. Sea ice and snow cover melt, turning brilliant white reflectors of sunlight into darker spots. The atmosphere grows moister because warmer air can hold more water vapor, which absorbs more shortwave radiation and the planet warms rapidly at the surface.

Meanwhile, Earth sheds longwave radiation more effectively, canceling out the longwave-trapping effects of CO2. However, a darker Earth now absorbs more sunlight, tipping the scales to net warming from shortwave radiation.

The paper is not challenging the physics of climate models; its value lies in helping the community interpret their output. One way the study can be useful is in guiding what researchers look for in satellite observations of Earth’s radiation budget, as they track anthropogenic climate change in the decades to come.

The work was supported by the National Oceanographic and Atmospheric Administration, the James S. McDonnell Foundation, and the National Science Foundation.


More efficient ways to power our flights
Industry-wide, air carriers set a goal to be carbon neutral by 2020 and to cut their emissions in half by 2050. One way they’ll meet this goal is through the use of biofuels.

“Biofuels release significantly fewer emissions than conventional fuel, and could reduce fuel price volatility for airlines,” says Niven Winchester, the lead author of a study looking at the costs and efficiency of making the switch.

To meet the global targets, the U.S. Federal Aviation Administration (FAA) has set its own goal to use one billion gallons of renewable biofuels each year starting in 2018. In studying this target, Winchester and his co-authors find that while a carbon tax or cap-and-trade system—as the Europeans have employed—would be the most efficient way to reduce emissions, there are ways to cut the costs of using biofuels. The study was published in *Transportation Research*. The researchers found that growing biofuel crops in rotation with food crops, as research from the U.S. Department of Agriculture suggests, can reduce the cost of biofuels.

The study was funded by the FAA.

http://newsoffice.mit.edu/2013/more-efficient-ways-to-power-our-flights-1202
A few of the leading other federal agencies providing funding are: the Department of Commerce, the Department of Transportation, the Federal Aviation Administration, the Intelligence Advanced Research Projects Activity, and the Environmental Protection Agency.

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2014
(shown in descending order of expenditures)

Computer Science and Artificial Intelligence Laboratory
Center for Transportation and Logistics
Aeronautics and Astronautics
Sea Grant College Program
Mechanical Engineering
Urban Studies and Planning
Earth System Initiative
Center for Global Change Science
Media Laboratory
Research Laboratory of Electronics

In fall 2014, Other Federal Agencies funded the primary appointments of graduate students with 50 research assistantships and 1 fellowship.

### Other Federal Agencies Campus Research Expenditures (in U.S. Dollars)
Fiscal Years 2010–2014

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*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.
rapidly to changes in blood-sugar levels. This could eliminate the need for patients to repeatedly monitor their blood sugar levels and inject insulin throughout the day.

Daniel Anderson and Robert Langer are the senior authors of a paper describing the engineered insulin in *Proceedings of the National Academy of Sciences*. The paper’s lead authors are Hung-Chieh (Danny) Chou, former postdoc Matthew Webber, and postdoc Benjamin Tang. Other authors are technical assistants Amy Lin and Lavanya Thapa, David Deng, Jonathan Truong, and Abel Cortinas.

The research was funded by the Leona M. and Harry B. Helmsley Charitable Trust, the Tayebati Family Foundation, the National Institutes of Health, and the Juvenile Diabetes Research Foundation.

http://newsoffice.mit.edu/2015/modified-insulin-better-diabetes-control-0209

**New way to turn genes on**

Using a gene-editing system originally developed to delete specific genes, MIT researchers have now shown that they can reliably turn on any gene of their choosing in living cells.

This new application for the CRISPR/Cas9 gene-editing system should allow scientists to more easily determine the function of individual genes, according to Feng Zhang. This approach also enables rapid functional screens of the entire genome, allowing scientists to identify genes involved in particular diseases. In a study published in *Nature*, Zhang and colleagues identified several genes that help melanoma cells become resistant to a cancer drug.

Silvana Konermann, a graduate student in Zhang's lab, and postdoc Mark Brigham are the paper’s lead authors.

The research was funded by the National Institute of Mental Health; the National Institute of Neurological Disorders and Stroke; the Keck, Searle Scholars, Klingenstein, Vallee, and Simons foundations; and Bob Metcalfe.


**Engineered insulin could offer better diabetes control**

For patients with diabetes, insulin is critical to maintaining good health and normal blood-sugar levels. However, it’s not an ideal solution because it can be difficult for patients to determine exactly how much insulin they need to prevent their blood sugar from swinging too high or too low.

MIT engineers hope to improve treatment for diabetes patients with a new type of engineered insulin. In tests in mice, the researchers showed that their modified insulin can circulate in the bloodstream for at least 10 hours, and that it responds
Leading Departments, Laboratories, and Centers

Receiving Support in Fiscal Year 2014

(Shown in descending order of expenditures)

- Computer Science and Artificial Intelligence Laboratory
- Mechanical Engineering
- Masdar
- Economics
- Koch Institute for Integrative Cancer Research
- Research Laboratory of Electronics
- Simons Center For The Social Brain
- Civil and Environmental Engineering
- McGovern Institute for Brain Research
- MIT-SUTD Collaboration

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.
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Lincoln Laboratory

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Lincoln Laboratory

MIT Lincoln Laboratory is a federally funded research and development center (FFRDC) operated by the Institute under contract with the Department of Defense (DoD). The Laboratory’s core competencies are in sensors, information extraction (signal processing and embedded computing), communications, integrated sensing, and decision support, all supported by a strong program in advanced electronics technology.

Since its establishment in 1951, MIT Lincoln Laboratory’s mission has been to apply technology to problems of national security. The Laboratory’s technology development is focused on its primary mission areas—space control; air and missile defense technology; communication systems; cyber security and information sciences; intelligence, surveillance, and reconnaissance systems and technology; advanced technologies; tactical systems; and homeland protection. In addition, Lincoln Laboratory undertakes government-sponsored, non-defense projects in areas such as air traffic control and weather surveillance.

Two of the Laboratory’s principal technical objectives are (1) the development of components and systems for experiments, engineering measurements, and tests under field operating conditions and (2) the dissemination of information to the government, academia, and industry. Program activities extend from fundamental investigations through the design process, and finally to field demonstrations of prototype systems. Emphasis is placed on transitioning systems and technology to industry.

MIT Lincoln Laboratory also emphasizes meeting the government’s FFRDC goals of maintaining long-term competency, retaining high-quality staff, providing independent perspective on critical issues, sustaining strategic sponsor relationships, and developing technology for both long-term interests and short-term, high-priority needs.

Authorized Funding by Sponsor FY2014*
Total Authorized Funding = $931.8 million

DARPA: Defense Advanced Research Projects Agency
DoD: Department of Defense
MDA: Missile Defense Agency
OSD Non-Line: Office of the Secretary of Defense
ASD Line: Assistant Secretary of Defense
Special category consists of other Government agencies

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.

Note, the mission charts on the following pages have been restated to Lincoln Laboratory’s current mission areas and include all sponsored research, DoD, and non-DoD.
*Research expenditure data are for the MIT fiscal year, July 1–June 30.

†Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Lincoln Laboratory’s Economic Impact

Lincoln Laboratory has generated and supported a range of national business and industrial activities. The charts below show the Laboratory’s economic impact by business category and state. In FY2014, the Laboratory issued subcontracts with a value that exceeded $363 million; New England states are the primary beneficiaries of the outside procurement program.

**Goods and Services (including subcontracts) Expenditures Fiscal Year 2014* (in $millions)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large business</td>
<td>179.1</td>
</tr>
<tr>
<td>Woman-owned small business</td>
<td>86.3</td>
</tr>
<tr>
<td>Veteran-owned small business</td>
<td>26.3</td>
</tr>
<tr>
<td>Small disadvantaged business</td>
<td>5.2</td>
</tr>
<tr>
<td>Other small business</td>
<td>55.1</td>
</tr>
<tr>
<td>Other Business (non-small business)</td>
<td>11.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>363.3</strong></td>
</tr>
</tbody>
</table>

**Top Seven States Amount**

| Massachusetts†                  | 185.3  |
| California                      | 30.1   |
| New Hampshire                   | 28.1   |
| Texas                           | 23.0   |
| Kentucky                        | 12.1   |
| New Jersey                      | 11.8   |
| Colorado                        | 11.3   |

**Other New England States Amount**

| Connecticut                     | 5.7    |
| Rhode Island                    | 1.2    |
| Vermont                         | 0.3    |
| Maine                           | 0.1    |

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
†Does not include orders to MIT ($21.1 million)
In the Air and Missile Defense Technology mission, Lincoln Laboratory develops and assesses integrated systems for defense against ballistic missiles, cruise missiles, and air vehicles in tactical, regional, and homeland defense applications. Activities include the investigation of system architectures, development of advanced sensor and decision support technologies, development of flight-test hardware, extensive field measurements and data analysis, and the verification and assessment of deployed system capabilities. A strong emphasis is on rapidly prototyping sensor and system concepts and algorithms, and on transferring resulting technologies to government contractors responsible for developing operational systems.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.
**Communication Systems**

Lincoln Laboratory is working to enhance and protect the capabilities of the nation’s global defense networks. Emphasis is placed on synthesizing communication system architectures, developing component technologies, building and demonstrating end-to-end system prototypes, and then transferring this technology to industry for deployment in operational systems. Current efforts focus on radio-frequency military satellite communications, free-space laser communications, tactical network radios, quantum systems, and spectrum operations.

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*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.*
**Cyber Security and Information Sciences**

Lincoln Laboratory conducts research, development, evaluation, and deployment of prototype components and systems designed to improve the security of computer networks, hosts, and applications. Efforts include cyber analysis; creation and demonstration of architectures that can operate through cyber attacks; development of prototypes that demonstrate the practicality and value of new techniques for cryptography, automated threat analysis, anti-tamper systems, and malicious code detection; and, where appropriate, deployment of prototype technology to national-level exercises and operations. To complement this work, advanced hardware, software, and algorithm technologies are developed for processing large, high-dimensional datasets from a wide range of sources. In the human language technology area, emphasis is placed on realistic data and experimental evaluation of techniques for speech recognition, dialect identification, speech and audio signal enhancement, and machine translation.

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*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.*
Intelligence, Surveillance, and Reconnaissance Systems and Technology

To expand intelligence, surveillance, and reconnaissance (ISR) capabilities, Lincoln Laboratory conducts research and development in advanced sensing, signal and image processing, automatic target classification, decision support systems, and high-performance computing. By leveraging these disciplines, the Laboratory produces novel ISR system concepts for both surface and undersea applications. Sensor technology for ISR includes passive and active electro-optical systems, surface surveillance radar, radio-frequency geolocation, and undersea acoustic surveillance. Increasingly, the work extends from sensors and sensor platforms to include the processing, exploitation, and dissemination technologies that transform sensor data into the information and situational awareness needed by operational users. Prototype ISR systems developed from successful concepts are then transitioned to industry and the user community.

Tactical Systems

In the Tactical Systems mission, Lincoln Laboratory assists the Department of Defense (DoD) in improving the development and employment of various tactical air and counterterrorism systems through a range of activities that include systems analysis to assess technology impact on operationally relevant scenarios, detailed and realistic instrumented tests, and rapid prototype development of U.S. and representative threat systems. A tight coupling between the Laboratory’s efforts and DoD sponsors and warfighters ensures that these analyses and prototype systems are relevant and beneficial to the warfighter.

![Graph showing authorized funding in millions for Intelligence, Surveillance, and Reconnaissance Systems and Technology and Tactical Systems from Fiscal Years 2010 to 2014.](image)

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.*
Space Control
Lincoln Laboratory develops technology that enables the nation’s space surveillance system to meet the challenges of space situational awareness. The Laboratory works with systems to detect, track, and identify man-made satellites; collects orbital-debris detection data to support space-flight safety; performs satellite mission and payload assessment; and investigates technology to improve monitoring of the space environment, including space weather and atmospheric and ionospheric effects. The technology emphasis is the application of new components and algorithms to enable sensors with greatly enhanced capabilities and to support the development of net-centric processing systems for the nation’s Space Surveillance Network.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Authorized Funding in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>170.2</td>
</tr>
<tr>
<td>2011</td>
<td>131.2</td>
</tr>
<tr>
<td>2012</td>
<td>157.0</td>
</tr>
<tr>
<td>2013</td>
<td>98.3</td>
</tr>
<tr>
<td>2014</td>
<td>147.0</td>
</tr>
</tbody>
</table>

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.
Advanced Technology

The Advanced Technology mission supports national security by identifying new phenomenology that can be exploited in novel system applications and by then developing revolutionary advances in subsystem and component technologies that enable key, new system capabilities. These goals are accomplished by a community of dedicated employees with deep technical expertise, collectively knowledgeable across a wide range of relevant disciplines and working in unique, world-class facilities. This highly multidisciplinary work leverages solid-state electronic and electro-optical technologies, innovative chemistry, materials science, advanced radio-frequency technology, and quantum information science.

Advanced Technology
Includes Special programs
Fiscal Years 2010–2014*

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.
Homeland Protection
The Homeland Protection mission supports the nation’s security by innovating technology and architectures to help prevent terrorist attacks within the United States, to reduce the vulnerability of the nation to terrorism, to minimize the damage from terrorist attacks, and to facilitate recovery from either man-made or natural disasters. The broad sponsorship for this mission area spans the DoD, the Department of Homeland Security (DHS), and other federal, state, and local entities. Recent efforts include architecture studies for the defense of civilians and facilities, new microfluidic technologies for DNA assembly and transformation and for gene synthesis, improvement of the Enhanced Regional Situation Awareness system for the National Capital Region, the assessment of technologies for border and maritime security, and the development of architectures and systems for disaster response.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.
Aviation Research
Since 1971, Lincoln Laboratory has supported the Federal Aviation Administration (FAA) in the development of new technology for air traffic control. This work initially focused on aircraft surveillance and weather sensing, collision avoidance, and air-ground data link communication. The program has evolved to include safety applications, decision support services, and air traffic management automation tools.

The current program is supporting the FAA’s Next Generation Air Transportation System (NextGen). Key activities include development of the next-generation airborne collision avoidance system; refinement and technology transfer of NextGen weather architectures, including cloud-processing and net-centric data distribution; and development of standards and technology supporting unmanned aerial systems’ integration into civil airspace.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30. Historic years are restated to represent current Lincoln Laboratory mission areas.
The projects supported by the Line are organized according to technology categories that have been selected to address gaps in existing and envisioned mission areas. Nine technology categories were selected to include both core and emerging technology initiatives. There are currently five core-technology areas in the Advanced Research Portfolio: advanced devices; optical systems and technology; information, computation and exploitation; RF systems and technology; and cyber security. In addition, there are four emerging-technology initiatives: novel and engineered materials, quantum system sciences, biomedical sciences, and autonomous systems.
Lincoln Laboratory Staffing
Lincoln Laboratory employs 1,740 technical staff, 433 technical support personnel, 1,055 support personnel, and 520 subcontractors. Three-quarters of the technical staff have advanced degrees, with 42% holding doctorates. Professional development opportunities and challenging cross-disciplinary projects are responsible for the Laboratory’s ability to retain highly qualified, creative staff.

Lincoln Laboratory recruits at more than 60 of the nation’s top technical universities, with 65 to 75% of new hires coming directly from universities. Lincoln Laboratory augments its campus recruiting by developing long-term relationships with research faculty and promoting fellowship and summer internship programs.
Test Facilities and Field Sites

Hanscom Field Flight and Antenna Test Facility
The Laboratory operates the main hangar on the Hanscom Air Force Base flight line. This ~93,000-sq-ft building accommodates the Laboratory Flight Test Facility and a complex of state-of-the-art antenna test chambers. The Flight Facility houses several Lincoln Laboratory–operated aircraft used for rapid prototyping of airborne sensors and communications.

Millstone Hill Field Site, Westford, MA
MIT operates radio astronomy and atmospheric research facilities at Millstone Hill, an MIT-owned, 1,100-acre research facility in Westford, Massachusetts. Lincoln Laboratory occupies a subset of the facilities whose primary activities involve tracking and identification of space objects.

Reagan Test Site, Kwajalein, Marshall Islands
Lincoln Laboratory serves as the scientific advisor to the Reagan Test Site at the U.S. Army Kwajalein Atoll installation located about 2,500 miles WSW of Hawaii. Twenty staff members work at this site, serving two- to three-year tours of duty. The site’s radars and optical and telemetry sensors support ballistic missile defense testing and space surveillance. The radar systems provide test facilities for radar technology development and for the development of ballistic missile defense techniques.

Other Sites
Pacific Missile Range Facility, Kauai, Hawaii
Experimental Test Site, Socorro, New Mexico
Section 5
MIT and Industry

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MIT Innovation Initiative 92
Entrepreneurship 93
Learning 93
Recruiting 95
MIT and Industry

Since its founding in 1861, MIT has fostered a problem-solving approach that encourages researchers to work together across departments, fields, and institutional boundaries. The resulting collaborations have included thousands of fruitful partnerships with industry.

- Over 700 companies provided R&D/gift support to MIT; 34 companies funded $1 million+, 196 companies funded $100 thousand–$1 million trillion in annual world sales.

Entrepreneurial Ecosystem

MIT also understands the fastest path from innovation to commercialization is often lead by young, entrepreneurial start-up companies, and the Institute has taken great care to design and build a unique, highly effective entrepreneurial ecosystem. It brings the world’s best and brightest into a culture of “Mens et Manus,” i.e. “mind and hand” focused on discoveries of real, practical impact and strong commercial value.

MIT’s vibrant entrepreneurial ecosystem benefits from its historical entrepreneurial culture, supported by specialized entrepreneurship programs and classes, student clubs, and networking across all MIT departments and schools and between MIT and the surrounding entrepreneurship and venture capital community. Formal MIT institutions like the Technology Licensing Office, Venture Mentoring Service, and the Deshpande Center for Technological Innovation are committed to the continued health and growth of the MIT entrepreneurial ecosystem.

The impact of MIT’s entrepreneurial ecosystem was quantified by a 2011 Kauffman Foundation Entrepreneurship Study:

- According to a 2009 Kauffman Foundation Entrepreneurship Study, 25,000+ companies have been founded by MIT alums creating 3.3+ million jobs and $2 trillion in annual world sales.
- Five states gaining the most jobs from companies started by MIT alumni were Massachusetts, with just under 1 million jobs; California, with 526,000 jobs; New York, with 231,000 jobs; Texas, with 184,000 jobs; and Virginia, with 136,000 jobs.
- MIT acts as a magnet for foreign entrepreneurs. Half of those companies created by “imported” entrepreneurs, 2,340 firms, are headquartered in the United States, generating their principal revenue ($16 billion) and employment (101,500 people) benefits here.

Partnering at MIT

Industry partners at MIT are global industry leaders who understand that technological advantage and innovation are key drivers to their competitive advantage. These are leaders who have created and defined industries, who quickly grasp the implications of breakthrough technology. Industry managers engage fully in MIT’s collaborative, interdisciplinary culture, and join big thinkers who are perpetually focused on wringing practical applications from excellent ideas.

Strategic Partnerships

In 1994, MIT began to build new kinds of research partnerships, creating longer-term alliances with major corporations that would allow these companies to work with MIT to develop programs and strategies that address areas of rapid change. In return for their research and teaching support, the corporations share ownership of patentable inventions and improvements developed from the partnership. In a number of these alliances, funds are earmarked for specific education projects.
A selection of these partnerships are described below.

**DuPont**
Established in 2000, the DuPont MIT Alliance (DMA) brings together each institution’s strengths in materials and chemical and biological sciences to develop new materials for bioelectronics, biosensors, biomimetic materials, alternative energy sources, and new high-value materials. DuPont also works with MIT’s Sloan School of Management to define new business and policy models for these emerging technologies. Each year, the DMA supports first-year graduate students through its DuPont Fellows program.

**Eni S.p.A**
In February 2008, an alliance was signed between Eni and MIT. This alliance brought the creation of the Eni-MIT Solar Frontiers Center (SFC). The SFC, headquartered on the MIT campus, promotes research in advanced solar technologies through projects ranging from new materials to hydrogen production from solar energy. Eni collaboration with MIT promotes the creation of technological and cultural synergies through a multidisciplinary approach. In particular, the cooperation between MIT researchers and those of the Research Center for Non Conventional Energy, Eni Donegani Institute, promotes the exchange of expertise through the pursuit of common objectives. In addition to the SFC, Eni supports projects in energy research at MIT on traditional hydrocarbons, methane hydrates, global climate change, and transportation options.

**Ford Motor Company**
Ford and MIT have been collaborating since the 1950s. In 1998 the Ford-MIT Alliance was formalized and has created a model for mutually beneficial university-corporate research. Ford and MIT collaborate on a broad range of technical, business, and policy topics focused on the future of transportation, including: vehicle autonomy, active safety, materials science, energy storage, powertrain efficiency, enterprise modeling, and health and wellness.

**Novartis**
Novartis and MIT have launched a long-term research collaboration aimed at transforming the way pharmaceuticals are produced. The partnership, known as the Novartis-MIT Center for Continuous Manufacturing, will work to develop new technologies that could replace the conventional batch-based system in the pharmaceuticals industry—which often includes many interruptions and work at separate sites—with continuous manufacturing processes from start to finish. The Novartis-MIT Center for Continuous Manufacturing combines the industrial expertise of Novartis with MIT’s leadership in scientific and technological innovation.

**Project Oxygen Alliance**
A partnership among the MIT Computer Science and Artificial Intelligence Laboratory and six corporations—Acer, Delta Electronics, Hewlett-Packard, Nippon Telegraph and Telephone, Nokia Research Center, and Philips Research—Project Oxygen’s goal is to make computation and communication resources as abundant and easy to use as oxygen. Working also with support from the Defense Advanced Research Projects Agency, the project seeks to free people from computer jargon, keyboards, mice, and other specialized devices they rely on now for access to computation and communication. For example, the researchers are creating speech and vision technologies that enable humans to communicate as naturally with computers as they do with people.

**Quanta Computing**
Taiwan-based Quanta Computer Inc., the world’s largest original design manufacturer of notebook computers, and MIT Computer Science and Artificial Intelligence Laboratory began the T-Party project collaboration in 2005. The goal of this project is to make the dream of having complete access to your own personalized environment—your notes, presentations, music, TV recordings, photo albums, recipes—from anywhere in the world, anytime a reality. The technologies they are exploring to support their vision fall into five categories: connectivity, devices, applications, automation, and natural interactions.
Selected Projects

MIT report identifies keys to new American innovation
An intensive, long-term study by a group of MIT scholars suggests that a renewed commitment to research and development in manufacturing, sometimes through creative new forms of collaboration, can spur innovation and growth in the United States as a whole. The findings are outlined in a 2013 report issued by a special MIT commission on innovation, called Production in the Innovation Economy, co-chaired by Suzanne Berger and Phillip A. Sharp. The report follows two years of in-depth research on hundreds of firms across various industrial sectors, ranging in size from high-tech startups to small “Main Street” manufacturers and multinational corporations.

MIT researchers build Quad HD TV chip
In January 2013, several manufacturers debuted new ultrahigh-definition, or UHD, models (also known as 4K or Quad HD) with four times the resolution of today’s HD TVs. In addition to screens with four times the pixels, UHD also requires a new video-coding standard, known as high-efficiency video coding, or HEVC. In February 2013, MIT researchers unveiled their own HEVC chip. The chip was designed by Anantha Chandrakasan, graduate students Mehul Tikekar and Chiraag Juvekar, former postdoc Chao-Tsung Huang, and former graduate student Vivienne Sze, now at Texas Instruments (TI). The researchers’ design was executed by the Taiwan Semiconductor Manufacturing Company, through its University Shuttle Program, and TI funded the chip’s development.

A cooler way to protect silicon surfaces
Silicon, the material of high-tech devices from computer chips to solar cells, requires a surface coating that “passivates” it to prevent oxidation that would ruin its electrical properties. Typically, silicon surfaces are passivated with a coating of silicon nitride, which requires heating a device to 400 degrees Celsius. By contrast, the process Karen Gleason, Tonio Buonassisi, and graduate student Rong Yang uses organic vapors over wires heated to 300°C, but the silicon itself never goes above 20°C—room temperature. Heating those wires requires much less power than illuminating an ordinary light bulb, so the energy costs of the process are quite low. The research was supported by the Italian energy company Eni S.p.A., under the Eni-MIT Alliance Solar Frontiers Program.

That’s the way the droplets adhere
Understanding exactly how droplets and bubbles stick to surfaces—everything from dew on blades of grass to the water droplets that form on condensing coils after steam drives a turbine in a power plant—is a “100-year-old problem” that has eluded experimental answers, says Kripa Varanasi. Furthermore, it’s a question with implications for everything from how to improve power-plant efficiency to how to reduce fogging on windshields. Now this long-standing problem has finally been licked, Varanasi says, in research he conducted with graduate student Adam Paxson. They achieved the feat using a modified version of a scanning electron microscope in which the dynamic behavior of droplets on surfaces at any angle could be observed in action at high resolution. The work was supported by the National Science Foundation and the DuPont-MIT Alliance.

Continuous drug manufacturing offers speed, lower costs
Traditional drug manufacturing is a time-consuming process. Active pharmaceutical ingredients are synthesized in a chemical manufacturing plant and then shipped to another site where they are converted into giant batches of pills. In 2007, MIT and pharmaceutical company Novartis launched a research effort, known as the Novartis-MIT Center for Continuous Manufacturing, to transform those procedures. Bernhardt Trout and other MIT researchers have now developed and demonstrated a prototype continuous-manufacturing system—the first that can transform raw materials into tablets in a nonstop process. In addition to Trout, MIT faculty members involved in the project include Klaas Jensen, Stephen Buchwald, Tim Jamison, Gregory Rutledge, Allan Myerson, Paul Barton, and Richard Braatz.
**Campus Research Sponsored by Industry**

**Industry Campus Research Expenditures (in U.S. Dollars)**

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>92,649,701</td>
<td>100,762,512</td>
<td>109,744,829</td>
<td>106,447,700</td>
<td>112,379,455</td>
</tr>
<tr>
<td>Constant dollars*</td>
<td>100,443,000</td>
<td>107,087,880</td>
<td>113,314,098</td>
<td>108,110,348</td>
<td>112,379,455</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.

**Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2014**

(shown in descending order of expenditures)

- MIT Energy Initiative
- Chemical Engineering
- Computer Science and Artificial Intelligence Laboratory
- Mechanical Engineering
- School of Management
- Koch Institute for Integrative Cancer Research
- Media Laboratory
- Civil and Environmental Engineering
- Chemistry
- Materials Science and Engineering

MIT is a leader in conducting research sponsored by industry. Over 200 industrial sponsors supported research projects on the MIT campus in FY2014, with over $112 million in expenditures. Companies often join together in these collaborations to support multi-disciplinary research programs in a wide range of fields.
Managing the Industry/University Interface
Drawing on decades of successful industry collaboration, MIT has assembled a coordinated team of professionals who expertly manage the important industry/university interface, leveraging and exploiting proven pathways for two-way knowledge transfer.

Industrial Liaison Program
Officers at MIT’s Industrial Liaison Program (ILP) help company managers by scheduling and facilitating face-to-face meetings with MIT faculty, coordinating on-campus networking activities, and advising company managers on how to navigate, adapt and benefit from the dynamic, interdisciplinary MIT environment. Two hundred of the world’s leading companies partner with the Industrial Liaison Program to advance their research agendas at MIT, and ILP member companies account for approximately 50% of all single-sponsored research expenditures and corporate gifts/grants at MIT (FY2013).

Office of Corporate Relations
MIT’s Office of Corporate Relations (OCR), the organizational parent of the ILP, aids and directs companies interested in pursuing significant, multi-year, multi-disciplinary involvement with the Institute. OCR works with MIT senior administration, faculty, and company execs to structure and define individualized alliances that mutually benefit the company and MIT. The result is a holistic industry/university relationship that addresses broad needs and interests, from specific research projects and initiatives, to executive education, technology licensing, and recruitment.

Technology Licensing Office
The MIT Technology Licensing Office (TLO) is a world class model of excellence in university technology licensing. Its staff is especially attuned to the needs of pre-competitive research and promotes an Intellectual Property protocol that accelerates commercialization, and, at the same time, honors MIT’s obligations to education and research. The TLO oversees a vibrant flow patenting/licensing activity

Technology Licensing Office Statistics for FY2014

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of invention disclosures:</td>
<td>743</td>
</tr>
<tr>
<td>Number of U.S. new utility patent applications filed:</td>
<td>231</td>
</tr>
<tr>
<td>Number of U.S. patents issued:</td>
<td>304</td>
</tr>
<tr>
<td>Number of licenses granted (not including trademarks and end-use software):</td>
<td>80</td>
</tr>
<tr>
<td>Number of options granted (not including options as part of research agreements):</td>
<td>27</td>
</tr>
<tr>
<td>Number of software end-use licenses granted:</td>
<td>18</td>
</tr>
<tr>
<td>Number of companies started (number of new license or option agreement to MIT technologies that serve as the foundation for a start-up company):</td>
<td>22</td>
</tr>
</tbody>
</table>

MIT Innovation Initiative
With its formation announced in Fall 2013, The MIT Innovation Initiative seeks to refine and optimize recognized Institute strengths—e.g. leadership in fundamental research, strong ties to industry, interdisciplinary collaboration—to accelerate MIT’s ability to deliver innovation: to identify problems and create solutions faster and more effectively, at every scale and for any context.

The Initiative reimagines how innovators, entrepreneurs, large corporations, risk capital providers and policy makers come together to solve the world’s greatest innovation challenges. Proposed elements include: an “Infinite Innovation Corridor,” new physical innovation space in which students, faculty and alumni can gather to play with new ideas, and develop their innovations; innovation education that embeds experiences in innovation throughout the curriculum; new research focused on production technologies and processes; and, an emphasis on “innovation science,” the rigorous evaluation of innovation and entrepreneurship programs and policies, particularly those that focus on accelerating the impact of tangible product and service innovation on the economy.

Fiona Murray, the Alvin J. Siteman (1948) Professor of Entrepreneurship, and Vladimir Bulović, the Fariborz Maseeh (1990) Professor of Emerging Technology, lead the MIT Innovation Initiative.
Entrepreneurship
Beginning with the founding of Arthur D. Little, Inc. in Cambridge in 1886, MIT alumni, faculty, and students have played key roles in launching thousands of companies worldwide, ranging from small, specialized high-tech operations to corporate giants such as Genentech, Gillette, Hewlett-Packard, Teradyne, and Raytheon. Many of these companies have formed the cornerstone of new industries, including biotechnology, streamlined digital technologies, local computer networks, defense, semi-conductors, minicomputers, advanced computers, and venture capital. MIT scientists and entrepreneurs laid the groundwork for much of the current biotech industry, and biomedical advances have continued with MIT-originated developments such as the first effective new treatment for brain cancer in a generation.

Martin Trust Center for MIT Entrepreneurship
The Martin Trust Center for MIT Entrepreneurship is committed to fostering and developing MIT’s entrepreneurial activities and interests in three primary areas: education and research, alliance, and community. The Center educates and nurtures students from across the Institute who are interested in learning the skills to design, launch, and grow innovation-based ventures. The Center facilitates business and technology partnerships by combining breakthrough academic research with practical, proven experience. The people of the Center cultivate and nourish a thriving network that unifies academic, government, and industry leaders around the vision of entrepreneurial success.

Deshpande Center for Technological Innovation
The Deshpande Center for Technological Innovation was established at the MIT School of Engineering in 2002 to increase the impact of MIT technologies in the marketplace, and support a wide range of emerging technologies including biotechnology, biomedical devices, information technology, new materials, tiny tech, and energy innovations. Since 2002, the Deshpande Center has funded more than 80 projects with over $9 million in grants. Eighteen projects have spun out of the center into commercial ventures, having collectively raised over $140 million in outside financing. Thirteen venture capital firms have invested in these ventures.

$100K Entrepreneurship Competition
The MIT $100K Entrepreneurship Competition (student group) is the leading business plan competition in the world. The competition was founded in 1990 to encourage students and researchers in the MIT community to act on their talent, ideas, and energy to produce tomorrow’s leading firms. Entirely student-managed, the competition has produced hundreds of successful ventures that have created value and employment.

Learning
Sloan Executive Education
MIT Sloan Executive Education programs are designed for senior executives and high-potential managers from around the world. From intensive two-day courses focused on a particular area of interest, to executive certificates covering a range of management topics, to custom engagements addressing the specific business challenges of a particular organization, their portfolio of non-degree, executive education and management programs provides business professionals with a targeted and flexible means to advance their career development goals and position their organizations for future growth.
Professional Education
MIT Professional Education provides short courses, semester or longer learning programs and customized corporate programs for science and engineering professionals at all levels. Taught by renowned faculty from across the Institute, MIT Professional Education programs offer professionals the opportunity to gain crucial knowledge in specialized fields to advance their careers, help their companies, and have an impact on the world.

- Short Programs—Over 40 courses, in two-to-five day sessions, are taught on the MIT campus each summer by MIT faculty/researchers and experts from industry and academia. Participants earn Continuing Education Units (CEUs) and a certificate of completion.

- Advanced Study Program—Enroll at MIT for a 16-week, non-matriculating, non-degree program that enables professionals to take regular MIT courses to gain the knowledge and skills needed to advance their careers and take innovative ideas back to their employers. Participants earn grades, MIT credit, and an Advanced Study Program certificate.

- Custom Programs—Enhance your organization’s capabilities and expertise through customized programs tailored to meet your specific needs and priorities. These programs can be a single week or several weeks over a year with interrelated projects. These specialized courses can be delivered at MIT, the company site, or off site.

Leaders for Global Operations
The Leaders for Global Operations (LGO) program is an educational and research partnership among global operations companies and MIT’s School of Engineering and Sloan School of Management. Its objective is to discover, codify, teach, and otherwise disseminate guiding principles for world-class manufacturing and operations. The 24-month LGO program combines graduate education in engineering and management for those with two or more years of full-time work experience who aspire to leadership positions in manufacturing or operations companies. A required six-month internship comprising a research project at one of LGO’s partner companies leads to a dual-degree thesis, culminating in two master’s degrees—an MBA (or SM in management) and an SM in engineering.

MIT Sloan Fellows Program in Innovation and Global Leadership
This full-time, 12-month (June–June) immersive MBA program is designed for high-performing mid-career professionals. The program typically enrolls more than 100 outstanding individuals with 10–20 years of professional experience from at least two dozen nations, representing a wide variety of for-profit and nonprofit industries, organizations, and functional areas. Many participants are sponsored by or have the strong support of their employers, but the program also admits independent participants, many with unique entrepreneurial experiences and perspectives. The program is characterized by a rigorous academic curriculum, frequent interactions with international business and government leaders, and a valuable exchange of global perspectives.
System Design and Management
The System Design and Management program educates engineering professionals in the processes of engineering and designing complex products and systems and gives them the management skills they need to exercise these capacities across organizations. Sponsored by the School of Engineering and the Sloan School of Management, the program offers a joint master’s degree from both schools. Students can pursue these degrees either on campus or through a hybrid on-campus/off-campus curriculum that uses video conferencing and web-based instruction.

Recruiting
Global Education and Career Development
The MIT Global Education and Career Development center assists employers in coordinating successful on- and off-campus recruitment of MIT students and provides students with opportunities to interact and network with professionals and obtain quality internships and full-time positions. MIT is proud to serve the needs of undergraduates (including Sloan), graduates and MIT alumni. (Departments that conduct their own recruiting include Chemistry, Chemical Engineering, and Sloan School of Management).

Sloan’s Career Development Office
Sloan’s Career Development Office (CDO) serves a vital role in connecting MIT Sloan’s innovative master’s students and alumni with the world’s leading firms. The CDO is dedicated to supporting employer recruiting goals and helping them identify the best candidates for their organization.
Section 6
Global Engagement

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Global Engagement

MIT’s problem-solving ambitions are global, and we cannot solve the most important world problems alone. Our wide-ranging international collaborations allow us access to outstanding students and colleagues, and provide our students with hands-on preparation for worldwide careers. Just as important, our global engagements lead us to important research problems and to fresh ways of thinking. While we are eager to share what we know, we go out into the world to learn.

President L. Rafael Reif

MIT strives to encourage the free flow of people and ideas by engaging in international research collaborations, providing international study and research opportunities for its students, and hosting international students and scholars. The following are some of MIT’s many international research collaborations.

Singapore

Singapore University of Technology and Design

In 2010, MIT and the Singapore University of Technology and Design (SUTD) officially began a partnership that includes both education and research components. Under the education component, MIT will share its expertise with SUTD in a broad range of areas, including pedagogy, curriculum development, and faculty recruitment and development. MIT will also assist in designing programs to encourage innovation and entrepreneurship. By March 31, 2015, MIT will have completed the delivery of nearly 100 courses to SUTD, 13 more than promised in the collaboration agreement. The second cohort has successfully finished its freshmen year. The third incoming class matriculated in May of 2014. Student exchanges have taken center stage as the second group of Singapore students arrived in June for their ten-week Global Leadership Program, and the third group of MISTI-Singapore students arrived at SUTD this June to assist in leadership training. A key feature of the research component is the SUTD-MIT International Design Centre (IDC). The IDC is a joint research project with facilities at both universities. The IDC aims to become the world’s premier scholarly hub for technologically intensive design and serve as a nucleus for the growth of the MIT-SUTD Collaboration.

Singapore-MIT Alliance for Research and Technology Centre

The Singapore-MIT Alliance for Research and Technology (SMART) Centre is a research enterprise established by MIT in partnership with the National Research Foundation of Singapore. The SMART Centre serves as an intellectual hub for research interactions between MIT and Singapore at the frontiers of science and technology. This partnership allows faculty, researchers, and graduate students from MIT to collaborate with their counterparts from universities, polytechnics, research institutes, and industry in Singapore and throughout Asia. The SMART Centre is MIT’s first research centre outside of Cambridge, Massachusetts, and its largest international research endeavor. See page 103 for information on Singapore-MIT Undergraduate Research Fellowships.

http://smart.mit.edu/

Russia

MIT Skoltech Initiative

In 2011, MIT and institutions in Russia launched a multi-year collaboration to help conceive and launch the Skolkovo Institute of Science and Technology (Skoltech), a new concept for a graduate university focused on a small number of pressing global issues and designed to stimulate the development of a research and innovation ecosystem in Russia. MIT serves as an advisor on programs, structure, and curriculum and has helped established the main elements of Skoltech’s educational programs, designing Master of Science programs in IT, Energy, and Biomedicine. MIT has helped design a domestic and international recruitment strategy and admissions process, leading to enrollment of the inaugural class of master’s degree students in academic year 2012—with MIT hosting 60% of this cohort for the 2012–2013 academic year in Cambridge. At the heart of Skoltech’s effort to address specific real-world problems is the establishment of 15 globally distributed Centers for Research, Education and Innovation (CREIs). MIT designed and implemented a multi-stage submission and international peer-review process, and launched new CREIs in Biomedicine (Stem Cells and Innovative Biomedical Therapies), and Electrochemical Energy Storage. Promoting innovation and entrepreneurship is central to Skoltech’s mission.
Toward that end, MIT and its partners have developed an entrepreneurship and innovation curriculum designed to provide foundational understanding in an action-based learning environment for its students, and have built the administrative and operational foundations for knowledge transfer and commercialization of emerging technologies. Skoltech is a private graduate research university in Skolkovo, Russia, a suburb of Moscow.

http://web.mit.edu/sktech/

India

Tata Center for Technology and Design
The Tata Center for Technology and Design was launched at MIT in the summer of 2012 thanks to the generosity of the Tata Trusts, and their Chairman, Mr. Ratan N. Tata. The goal of the Center is to create a graduate education program that teaches students how to apply deep technical knowledge to the challenges of the developing world, guided by direct experience in India. The program is open to graduate students from all MIT schools. The students, known as Tata Fellows, develop thesis projects that respond to large-scale opportunities to use technology to improve the lives of people in India. Rapid progress has been made to develop a sister center in India at IIT-Bombay, which was launched in May 2014, and enrolled its first cohort in July 2014. The Centers have a similar mission and curriculum, and many faculty and student exchange activities are planned to reinforce and deepen the connection between them. The first joint conference took place in Mumbai in August 2014.

http://tatacenter.mit.edu/

China

China Leaders for Global Operations
The China Leaders for Global Operations (CLGO) program was started in 2005 as a collaboration of MIT and the Shanghai Jiao Tong University (SJTU). The program was launched at the request of LGO industry partners to strengthen LGO global content for faculty and students, help partner companies’ operations in China, and promote global manufacturing. CLGO offers China’s only dual-degree, graduate-level academic program. The CLGO program is jointly offered by SJTU’s two engineering schools, the SJTU Antai College of Economics and Management, and a dedicated group of CLGO industry partners. Graduates of the CLGO program receive the MBA degree from Antai, an S. M. degree from one of two SJTU engineering schools, and a certificate from the MIT LGO program. MIT supports the China LGO program by hosting SJTU faculty (32 to date) at MIT for extensive mentoring in courses that they in turn lead for the CLGO program, and by providing the all-English language CLGO curriculum. In addition, a review committee of MIT faculty makes periodic visits to meet CLGO stakeholders and assess the program’s quality. MIT LGO and China LGO students collaborate each year through visits to Shanghai and Cambridge, including joint plant tours of partner company sites.

MIT China Educational Technology Initiative
The MIT-China Educational Technology Initiative (CETI) is MISTI-China’s educational technology internship program. Since 1997, MIT-CETI has trained small teams of MIT students to work with numerous universities and high schools in China, building cross-cultural understanding between Chinese and American students through the application of technology. Approximately 20 MIT students participate in CETI each year in full summer and longer internships. CETI has established educational technology programs with Chinese universities through partnerships with MIT OpenCourseWare (OCW) and MIT-iCampus. CETI university partners include Dalian University of Technology, Huazhong University of Science and Technology (Wuhan), Fuzhou University, Xi’an Jiaotong University, Yunlin University (Shaanxi Province), Qinghai University, Sichuan University, Kunming University of Science and Technology, Institute of Vocational Engineering (Hong Kong), and YuanZe University (Taiwan). In recent years, CETI has also held several educational technology summer camps at Tsinghua and Zhejiang universities in the departments of information technology. Additionally, in summer 2014, CETI has started collaborating with Google and MIT App Inventor organizing mobile phone applications workshops at Tianjin University, Shanghai World Foreign Languages Middle School, Shenzhen Institute of Information Technology, South China University of Technology, Lanzhou University, and Gansu Radio & Television University.
Middle East
Center for Clean Water and Clean Energy at MIT and KFUPM
Technologies related to the production of fresh water and low-carbon energy are the focus of a research and educational partnership between faculty in MIT’s Department of Mechanical Engineering and King Fahd University of Petroleum and Minerals (KFUPM) in Dhahran, Saudi Arabia. The joint program operates through the Center for Clean Water and Clean Energy, and it includes projects on topics such as desalination, solar energy, nanoengineered membranes, leak detection, and advanced manufacturing. The eight-year collaboration includes more than a dozen large-scale collaborative research projects and a number of education and curriculum development projects. Approximately 25 MIT faculty are involved, with a similar number at KFUPM, and an overall head count (including graduate students and postdocs) of more than 150 people between the two schools. KFUPM faculty and graduate students have the opportunity to spend one or two semesters at MIT, and MIT faculty visit KFUPM for one to two weeks each year. The Center also includes a unique outreach program that brings Saudi women engineers and scientists to MIT for research with our faculty. The Center is directed by Professor John H. Lienhard V and co-directed by Professor Kamal Youcef-Toumi.

CSAIL-Qatar Computing Research Institute
The CSAIL-Qatar Computing Research Institute (QCRI) research collaboration, called the Computer Science Research Program, is a medium for knowledge transfer and exchange of expertise between MIT-CSAIL and QCRI scientists. Scientists from both organizations are undertaking a variety of core computer science research projects, with the goal of developing innovative solutions that can have a broad and meaningful impact. The agreement also offers CSAIL researchers and students exposure to the unique challenges in the Gulf region. Through the Computer Science Research Program, researchers’ plans are focusing on several critical areas in the field of computing including cyber security, Arabic speech and language processing, advanced analytics and visualization in sports, data management for social computing, and data integration. Scientists at QCRI are benefiting from the expertise of MIT’s eminent faculty through joint research projects that will enable QCRI to realize its vision to become a premier center of computing research regionally and internationally.

Kuwait-MIT Center for Natural Resources and the Environment
The Kuwait-MIT Center for Natural Resources and the Environment (CNRE) was established in 2005 bringing together faculty, students, and scientists to improve scientific and technical understanding of issues of natural resources, the environment, and related challenges. The mission of the Center is to foster collaborations in research and education in areas of Energy, Water and the Environment that are of mutual interest to research institutions in Kuwait and MIT. The Center sponsors a number of programs including grants to support collaborative research funding, and visitor exchange programs via post-doctoral fellowships and student internships. The Center is funded by the Kuwait Foundation for the Advancement of Sciences (KFAS). Its leadership team consists of Faculty Director: Prof. Mujid Kazimi of NSE and MechE; Associate Director: Prof. Jacopo Buongiorno of NSE; and Executive Director: Dr. Murad Abu-Khalaf. http://cnre.mit.edu/

MIT and Masdar Institute Cooperative Program
In 2006, MIT began collaborating with the government of Abu Dhabi to establish a graduate research university focused on alternative energy, sustainability, and advanced technology. Since then, Masdar Institute has grown to over 85 outstanding faculty and over 428 graduate students. MIT and Masdar Institute have collaborated on 62 research projects to date and the Cooperative Program continues to support Abu Dhabi’s goal of developing human capital for a diversified knowledge-based economy. By ensuring high-quality, graduate education and advanced research, Masdar Institute prepares a high-caliber workforce to keep pace with ever-increasing technological changes and a growing research and development culture. The Cooperative Program offers MIT and Masdar Institute faculty and students access to new talent, ideas, and rich research and educational collaborations.

http://web.mit.edu/mit-mi-cp/
http://www.masdar.ac.ae/
Portugal

MIT Portugal Program
The MIT Portugal Program was launched in October 2006 by the Portuguese Ministry of Science, Technology, and Higher Education as a large-scale international collaboration connecting MIT to government, academia, and industry in Portugal. The aim of the program is to transform the Portuguese economy by developing globally competitive higher education and research programs and synergies in: bioengineering systems, sustainable energy and transportation systems, and engineering design and advanced manufacturing. These academic-research initiatives are complemented by an array of ecosystem-building activities, including innovation and leadership training as well as a highly successful venture competition. The partnership has recently been extended (2013–2017), underscoring its importance and impact for the Portuguese government and the value MIT brings to the country.

Other Global Initiatives

Global Supply Chain and Logistics Excellence (SCALE) Network
The MIT Center for Transportation and Logistics (MIT-CTL) created the MIT Global Supply Chain and Logistics Excellence (SCALE) Network in 2003 as an international alliance of leading research and education centers dedicated to the development and dissemination of supply chain and logistics innovation. This international network now spans four continents with Centers in North America (MIT CTL), Europe (Zaragoza, Spain), South America (Bogota, Colombia), and Asia (Kuala Lumpur, Malaysia). Each SCALE Center fosters relationships between its local students, faculty, and businesses as well as those across the network. More than 100 graduate students are enrolled annually in the various SCALE supply chain educational programs; each of which includes a three week student & faculty exchange at MIT. The SCALE Network also features partnerships with close to a hundred global corporations, such as Procter & Gamble, UPS, BASF, and Wal-Mart, that sponsor research, participate in events, and recruit students. Research projects recently undertaken by the SCALE network include projects on decision making under uncertainty, supply chain resilience, humanitarian logistics, sustainable supply chains, and global transportation reliability.

Center for Advanced Urbanism
The overall goal of the MIT Center for Advanced Urbanism (CAU) is to establish a new theoretical and applied research platform to transform the quality of urban life. The Center is committed to achieving this goal via collaborative interdisciplinary research projects, intellectual discourse, leadership forums and conferences, publications, education of a new generation of leaders in the field, and a distinctive, highly influential presence at international gatherings focused on urbanism.
Digital Learning

OpenCourseWare (OCW) and MITx represent MIT’s largest and most far-reaching international outreach programs. With more than 2,200 courses on OCW, many of them available in other languages through OCW translation affiliates in other countries, there is something of interest for almost everyone. Since 2003, more than 150 million individuals have accessed MIT academic content through these programs, sometimes with astonishing results. Please see http://ocw.mit.edu/about/ocw-stories/ for inspiring examples.

OCW is accessed by a broadly international population of educators and learners, with 55%-60% of all visitors accessing OCW from outside the U.S. in a typical month.

MITx is MIT’s online learning initiative (“MOOC”), offering global access to a portfolio of free MIT courses taught by MIT faculty through the edX interactive teaching and learning platform. Students must enroll in these courses, and they have the opportunity to earn certificates of achievement. Since the first MITx course was offered in August 2012, more than 900,000 individuals around the world have registered, some for multiple courses (more than 1.3 million enrollments). Individual registrants come from more than 200 countries.
Global Engagement

International Study Opportunities
There are a broad range of global activities for students to choose from. These run the gamut from traditional study-abroad programs to innovative short term projects, but most are infused with the Institute’s philosophy of mens et manus. In the spring of 2014, 43 percent of students graduating with a bachelor’s degree, and 32 percent of students graduating with a master’s degree reported having educational experiences abroad.

The following are examples of programs that provide students with experiences abroad:

Cambridge-MIT Exchange
Through the Cambridge-MIT Exchange Program (CME), undergraduate MIT students can spend their junior year studying at the University of Cambridge in England. The University of Cambridge consists of 31 colleges where students live and study in a supportive educational environment. Participating departments include Aeronautics and Astronautics; Biology; Brain and Cognitive Sciences; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Earth, Atmospheric and Planetary Sciences; Economics; Electrical Engineering and Computer Science (including Course 6-3); History; Mathematics; Mechanical Engineering; and Physics.

Departmental Exchanges
The Department of Aeronautics and Astronautics offers study at the University of Pretoria in South Africa. The Department of Architecture has two exchange programs, one with Delft University of Technology in the Netherlands and the other with the University of Hong Kong. The Department of Materials Science and Engineering has exchange programs with Oxford University and Imperial College London. The Department of Political Science has an exchange program with Sciences Po in Paris, France. The Department of Mechanical Engineering has an exchange program with ETH-Zurich in Switzerland.

MIT-Madrid Program
The MIT-Madrid Program gives students the opportunity to study in Madrid for the spring term during their sophomore or junior year. Depending upon major and interests, students can choose science and engineering courses at the Universidad Politécnica de Madrid and/or humanities, arts, and social sciences courses at the Universidad Complutense de Madrid; instruction and coursework are in Spanish. These are leading universities in Spain, each with its own distinguished tradition and history. In addition to academic courses, students can participate in an internship during this program.

Singapore-MIT Undergraduate Research Fellowships (SMURF)
The SMART Centre has established a summer research internship programme: the SMURF programme (Singapore-MIT Undergraduate Research Fellows programme). It is open to all undergraduates at MIT, NTU, and NUS and gives them the opportunity to engage in research at the SMART Centre over the summer. The SMURFs work in MIT Faculty supervisors’ labs, actively participate in the research projects, and engage with postdoctoral scholars, graduate students, and other researchers. SMART hopes this opportunity excites them about research and they consider a career in research. Their research experiences are supplemented with numerous social activities that are arranged for them. Based on feedback from the students, the SMURFS greatly value their experiences at SMART and the community that forms among them.

Other Study Abroad Options
MIT students may also apply for admission directly to foreign institutions that offer study abroad programs or to a study abroad program administered by another U.S. institution or study abroad provider. Examples of such opportunities include l’École Polytechnique in France, the London School of Economics, Oxford University and other UK institutions, and a number of programs in China.
MIT International Science and Technology Initiatives

MIT International Science and Technology Initiatives (MISTI), MIT’s primary international program, connects MIT students and faculty with research and innovation around the world. Working closely with a network of premier corporations, universities and research institutes, MISTI matches over 680 MIT students with internship, teaching and research opportunities abroad each year. After several semesters of cultural and language preparation on campus, MISTI students participate in rigorous, practical work experience in industry and in academic labs and offices. Projects are designed to align the skills and interests of the student with the needs of the host. MISTI also organizes the MISTI Global Seed Funds, which encourage MIT students to work on faculty-led international research and projects. MISTI programs are available in Africa, Belgium, Brazil, Chile, China, France, Germany, India, Israel, Italy, Japan, Korea, Mexico, the Netherlands, Russia, Singapore, Spain, and Switzerland.

MISTI’s approach to international education builds on MIT’s distinctive traditions of combining classroom learning and hands-on experience in Undergraduate Research Opportunities (UROPs), cooperative programs with industry, practice schools, and internships. In contrast to other universities’ internationalization programs that mainly involve study abroad, MISTI matches individual students with work or research opportunities in their own fields.

MISTI was awarded the 2013 Senator Paul Simon Spotlight Award by NAFSA: Association of International Educators. According to NAFSA Executive Director and CEO Marlene M. Johnson, winners of the Simon Award are “excellent models for how higher education across the country can and must innovate to prepare our students for the global economy we live in today.”

Here are a few examples from the more than 4,000 students MISTI has placed since it began by sending a handful of interns to Japan at the end of the 80s:

Chemical Engineering student Nathalia Rodriguez worked on gene therapy for muscular dystrophy at Genpole, a French biotech cluster.

Matthew Zedler, a Mechanical Engineering graduate, examined Chinese auto growth and energy at Cambridge Energy Research Associates in Beijing.

Physics major Jason Bryslawskyj designed superconducting magnetic bearings for electric motors at Siemens in Germany. He wrote two patents at Siemens.

Ammar Ammar, an EECS undergrad, designed and tested a Google/YouTube project at Google Israel.

http://web.mit.edu/misti/
MISTI Programs and Start Year

- Belgium, 2011
- Brazil, 2009
- Chile, 2011
- China, 1994
- France, 2001
- Germany, 1997
- India, 1998
- Israel, 2008
- Italy, 1999
- Japan, 1983
- Korea, 2012
- Mexico, 2004
- Netherlands, 2012
- Russia, 2012
- Singapore, 2012
- Spain, 2006
- Switzerland, 2010

*MISTI year runs from September 1–August 31. 2014 represents the 2013–2014 year.


MISTI Annual Internship Placements

1994–2014*

*MIT year runs from September 1–August 31. 2014 represents the 2013–2014 year.
International Students
MIT has welcomed international students essentially since its inception. The first student from Canada came to MIT in 1866, the second year MIT offered classes. This student was followed by a steady stream of students from around the globe throughout the 19th century. By 1900, some 50 foreign-born students had traveled to Massachusetts for study; however, the number increased dramatically after World War II when an influx of these students began attending the Institute. The rapid rise of international students from East Asia, led by students from China, changed the demographics of this group beginning in the 1950s. Changes in immigration law in 1965 opened up the doors to a steadily increasing pool of international talent.

The United States has been the destination of choice for international students and scholars for the past 50 years. According to the Institute of International Education Open Doors 2014 report, the number of international students enrolled in U.S. colleges during the 2013–2014 academic year reached a record high of 886,000 students. MIT is ranked 38th in the report’s “International Students by Institutional Type: Top 40 Doctorate-granting Universities Hosting International Students, 2013/14” list. NAFSA: Association of International Educators produced an economic analysis based in part on Open Doors data that states that during the 2013–2014 academic year, international students and their dependents contributed $26.8 billion to the U.S. economy through tuition and fees, and living expenses.
International Undergraduate Students
Top Countries of Citizenship, 2014–2015

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<thead>
<tr>
<th>Country</th>
<th>Count</th>
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<tbody>
<tr>
<td>China</td>
<td>62</td>
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<tr>
<td>South Korea</td>
<td>28</td>
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<td>Canada</td>
<td>23</td>
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<td>India</td>
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<td>Thailand</td>
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<td>Brazil</td>
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<td>Saudi Arabia</td>
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<td>Mexico</td>
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<td>Singapore</td>
<td>9</td>
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<tr>
<td>Taiwan</td>
<td>9</td>
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<tr>
<td>United Kingdom</td>
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</tbody>
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International Graduate Students
Top Countries of Citizenship, 2014–2015

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<th>Country</th>
<th>Count</th>
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<td>Singapore</td>
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<td>Germany</td>
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<td>Israel</td>
<td>67</td>
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<tr>
<td>Japan</td>
<td>62</td>
</tr>
</tbody>
</table>

International Students by Geographic Region of Country of Citizenship
1884–2015

[Graph showing trends over time with various regions and countries indicated by different colors.]
Many international students remain in the U.S. after graduation. The graph below shows the post-graduation plans of international students graduating in 2014, as reported in a survey administered by MIT. Seventy-four percent of international students plan to remain in the U.S. after graduation.

### International Alumni Entrepreneurs

A 2009 Kauffman Foundation report on the Entrepreneurial Impact of MIT found the following:

Alumni who were not U.S. citizens when admitted to MIT founded companies at different (usually higher per capita) rates relative to their American counterparts, with at least as many remaining in the United States as are returning to their home countries....

About 30 percent of the foreign students who attend MIT found companies at some point in their lives. This is a much higher rate than for U.S. citizens who attend MIT. We assume (but do not have data that might support this) that foreign students are more inclined from the outset to become entrepreneurs, as they had to seek out and get admitted to a foreign university, taking on the added risks of leaving their families and their home countries to study abroad. (MIT has only its one campus in Cambridge, Mass., and, despite collaborations in many countries, does not operate any degree program outside of the United States.) We estimate that about 5,000 firms were started by MIT graduates who were not U.S. citizens when they were admitted to MIT. Half of those companies created by “imported” entrepreneurs, 2,340 firms, are headquartered in the United States, generating their principal revenue ($16 billion) and employment (101,500 people) benefits here.
International Alumni

MIT alumni and scholars have made extraordinary contributions in their home countries, the U.S., and the world. The following are some examples:

Kofi Annan, SM Management 1972
Kofi Annan, the seventh Secretary-General of the United Nations and recipient of the Nobel Peace Prize, was born in Kumasi, Ghana, and attended the University of Science and Technology in Kumasi before completing his undergraduate studies at Macalester College in St. Paul, Minnesota. He undertook graduate studies in economics at the Institut universitaire des haute etudes internationals in Geneva, and earned his SM in Management as a Sloan Fellow at MIT. Annan worked for the World Health Organization and the Ghana Tourist Development Company, but has spent most of his career at the United Nations.

Mario Draghi, PhD Economics 1977
Mario Draghi is the president of the European Central Bank (ECB) which sets interest rates for the 17 countries in the Eurozone. He was previously the governor of the Bank of Italy and, in 2012, Forbes Magazine nominated him as the 8th most powerful man in the world. Shortly after becoming president of the ECB, he oversaw a €489 billion ($640 billion), three-year loan program to European banks. He also stepped up the bond purchases from struggling Eurozone nations to help with the debt crisis. Draghi was born in Rome in 1947. He received a degree in economics from Universita degli Studi, Rome in 1970 before attending MIT. While at MIT, he studied with Nobel winners Franco Modigliani and Robert Solow.

Benjamin Netanyahu, SB Architecture 1975, SM Management 1976
Currently serving his second term as Prime Minister of Israel, Benjamin Netanyahu was born in 1949 in Tel Aviv, Israel and grew up in Jerusalem. He served as Israel’s ambassador to the United Nations from 1984 to 1988, during which time he led the effort to declassify the United Nations’ archive on crimes committed by Nazi Germany. Netanyahu, a member of the Likud party, was Israel’s Prime Minister from 1996 until 1999. During his first term as Prime Minister, Netanyahu implemented policy that combined fighting terror with advancement of the peace process. Its cornerstone was the conclusion of well-measured agreements with the Palestinians that insisted on reciprocity. During his three-year term, the number of terror attacks drastically decreased.

Ngozi Okonjo-Iweala, MCP 1978, PhD Planning 1981
Former Managing Director of the World Bank, Ngozi Okonjo-Iweala is a globally renowned Nigerian economist. She was the first woman to hold the position of Finance Minister in Nigeria. During her term from 2003 to 2006, she launched an aggressive campaign to fight corruption. She implemented a series of economic and social reforms, including a zero-tolerance policy for corruption; international and local governmental contract bidding; privatizing state-owned refineries; and the Extractive Industry Transparency Initiative, which aims to bring openness to the oil sector. Under her leadership, the country has tripled its reserves from $7 billion to $20 billion; the annual GDP grew at 6 percent; and inflation is down from 23 percent to 9.5 percent. Okonjo-Iweala started her career at the World Bank, where she was the first woman ever to achieve the positions of vice president and corporate secretary.

I. M. Pei, SB Architecture 1940
Ieoh Ming Pei, influential modernist architect and founder of the firm Pei Cobb Freed & Partners, was born in China in 1917. He completed his Bachelor of Architecture degree at MIT in 1940. Pei has designed more than 60 buildings, including the John Fitzgerald Kennedy Library in Boston, Massachusetts, the Grand Louvre in Paris, France, the Miho Museum in Shiga, Japan, the Bank of China Tower in Hong Kong, and the Gateway Towers in Singapore.

Tony Tan, SM Physics 1964
Following his degrees from MIT and his Ph.D. from the University of Adelaide in applied mathematics, Tan taught mathematics at the University of Singapore. Tan was elected to the Parliament of Singapore in 1979, and has served in numerous leadership positions in the Singapore government. In December 1991, Tan stepped down from the Cabinet to return to the private sector as the Overseas-Chinese Banking Corporation’s Chairman and Chief Executive Officer. He rejoined the Cabinet in 1995 as Deputy Prime Minister and Minister for Defense. In August 2003, Tan became Deputy Prime Minister and Co-ordinating Minister for Security and Defense. Tan won the Singapore presidential election in 2011 and is currently serving as the 7th President of Singapore.
International Scholars
MIT hosts international scholars from around the world who come to the U.S. for teaching, research, collaboration, and other purposes. This diverse group of professionals includes visiting scientists, professors, artists, and scholars, as well as postdoctoral fellows and associates, lecturers, instructors, research associates and scientists, and tenure-track faculty. During the year July 1, 2013 through June 30, 2014, The International Scholars Office (ISchO) served 2,305 international scholars affiliated with MIT and their accompanying family members (“international” is defined as non-U.S. citizen, non-U.S. permanent resident).

This reflects an increase of nearly 2.6 percent over last year (2,248). According to the most recently published Institute of International Education Open Doors report (2012-13), MIT ranked 9th nationally with regard to the numbers of international scholars at U.S. institutions. Postdoctoral associates and postdoctoral fellows accounted for 58 percent of MIT’s international scholars.

Foreign national scholars came to MIT from 90 different countries, with the highest numbers coming from China, South Korea, Germany, Canada, India, Japan, France, Italy, Israel, and Spain. The top ten countries of origin of the entire international scholar population in the U.S. are roughly the same. Scholars from these top 10 countries constituted 65 percent of MIT’s international scholar population. Seventy-six percent of international scholars at MIT were men and 24 percent were women. The greatest number of international scholars came to join departments in the School of Engineering, followed by the School of Science, interdisciplinary laboratories and centers, and the Sloan School of Management.
Global Engagement

Selected Projects

Small volcanoes make a dent in global warming
New research shows that relatively small volcanic eruptions can increase aerosol particles in the atmosphere, temporarily mitigating the global warming caused by greenhouse gases. The impact of such smaller eruptions has been underestimated in climate models, the researchers say, and helps to account for a discrepancy between those models and the actual temperatures observed over the last 15 years.

The findings are reported in a paper in the journal Geophysical Review Letters, co-authored by Susan Solomon, postdoc David Ridley, and 15 others. They help to explain the apparent slowdown in the pace of global warming recorded over the last 10 to 15 years—possibly explaining as much as half of that slowdown, the researchers say.

The cooling effect of large volcanic eruptions, such as that of Mount Pinatubo in the Philippines in 1991, was already widely recognized; the new work shows that smaller eruptions can have a significant cooling effect as well, and provides a better estimate of how much of the recent reduction in warming could be explained by such eruptions: about 30 to 50 percent of the discrepancy, the team found.

The team found that small eruptions produce a significant amount of aerosol particles, which reflect sunlight, in a region of the upper atmosphere that is relatively poorly monitored: Satellites can provide good data about the atmosphere down to around 15 kilometers above ground level, below which clouds interfere. The team filled in the missing region using multiple balloon, laser radar (lidar), and ground-based measurements. Aerosols in that intermediate zone, from about a dozen modest eruptions around the world during the last 15 years, may double previous estimates of the cooling effect of eruptions, Ridley says.

Overall, these smaller eruptions have lowered the increase of global temperature since 2000 by 0.05 to 0.12 degrees Celsius, counteracting some of the warming that would otherwise have occurred. Now, using this new information, groups that carry out climate modeling can update their models to more accurately project global climate change over the coming decades, Ridley says.

Ridley and Solomon were the lead authors of the paper, joining authors from Wyoming, Russia, Germany, Japan, California, New York, Virginia, Colorado, and the U.K. The work was supported by the National Science Foundation, the Ministry of Science and Education of the Russian Federation, and the Russian Science Foundation.

http://newsoffice.mit.edu/2014/small-volcanoes-slow-global-warming-1203

Solid nanoparticles can deform like a liquid
A surprising phenomenon has been found in metal nanoparticles: They appear, from the outside, to be liquid droplets, wobbling and readily changing shape, while their interiors retain a perfectly stable crystal configuration.

The research team behind the finding, led by Ju Li, says the work could have important implications for the design of components in nanotechnology, such as metal contacts for molecular electronic circuits. The results, published in the journal Nature Materials, come from a combination of laboratory analysis and computer modeling, by an international team that included researchers in China, Japan, and Pittsburgh, as well as at MIT.

The researchers’ detailed imaging with a transmission electron microscope and atomistic modeling revealed that while the exterior of the metal nanoparticles appears to move like a liquid, only the outermost layers—one or two atoms thick—actually move at any given time. As these outer layers of atoms move across the surface and redeposit elsewhere, they give the impression of much greater movement—but inside each particle, the atoms stay perfectly lined up, like bricks in a wall.

The research team included Jun Sun, Longbing He, Tao Xu, Hengchang Bi, and Litao Sun, all of Southeast University in Nanjing, China; Yu-Chieh Lo of MIT and Kyoto University; Ze Zhang of Zhejiang University; and Scott Mao of the University of Pittsburgh. It was supported by the National Basic Research Program of China; the National Natural Science Foundation of China; the Chinese Ministry of Education; the National Science Foundation of Jiangsu Province, China; and the U.S. National Science Foundation.

### International Organizations Campus Research Expenditures (in U.S. Dollars)
#### Fiscal Years 2010-2014

<table>
<thead>
<tr>
<th>International Sponsor Type</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations and other nonprofits</td>
<td>23,170,052</td>
<td>20,233,545</td>
<td>25,025,346</td>
<td>29,381,412</td>
<td>35,830,415</td>
</tr>
<tr>
<td>Industry</td>
<td>41,030,728</td>
<td>45,603,282</td>
<td>48,133,890</td>
<td>41,922,158</td>
<td>42,127,804</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>96,834,218</strong></td>
<td><strong>98,308,146</strong></td>
<td><strong>110,872,115</strong></td>
<td><strong>103,954,737</strong></td>
<td><strong>106,762,179</strong></td>
</tr>
<tr>
<td>Constant dollars*</td>
<td>104,979,501</td>
<td>104,479,441</td>
<td>114,478,047</td>
<td>105,578,447</td>
<td>106,762,179</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2014 equaling 100.
Section 7
Service to Local and World Communities

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Founded with the mission of advancing knowledge to serve the nation and the world, MIT has been strongly committed to public service from its start. While MIT faculty, students, and staff regularly engage in conventional projects such as raising money for hurricane victims, renovating old housing, or restoring local nature reserves, MIT’s scientific and technological orientation gives much of its public service outreach a particular emphasis. Many of its public service programs are specifically devoted to inventing new technologies and applying new knowledge that will advance social well-being.

Public Service Center
The Public Service Center (PSC) offers MIT students multiple ways to assist communities beyond MIT while expanding their own education and life experiences. The guidance, resources, and support offered by the PSC help students to identify public service options that suit their passions and abilities.

The PSC helps students gain hands-on experiences that serve communities and the students themselves in life-transforming ways. Through fellowships, internships, and grants; the IDEAS Global Challenge; programs such as Four Weeks for America and the Freshmen Urban Program; community service work-study positions; and advising resources, students can engage in a variety of opportunities.

http://web.mit.edu/mitpsc/

Fellowships, Value-Added Internships, and Grants
Locations as near as Boston or as far as Bangladesh offer many opportunities to work on community issues, whether it is designing community spaces for domestic violence survivors in Boston, scrutinizing labor practices in the electronics industry in Mexico, or developing a business plan for villagers to produce and sell silk garments in Thailand. As a subset of its internships program, the PSC also offers specialized opportunities for students in the Department of Civil and Environmental Engineering and the Department of Urban Studies and Planning.

MIT IDEAS Global Challenge
Students form teams to design and implement innovative projects for community partners in order to improve the quality of life of individuals around the world. Since 2001, the IDEAS Global Challenge has awarded more than $600,000 to 117 teams to make their ideas a reality. These teams have implemented innovative service projects in 41 countries, serving the needs of hundreds of thousands of people.

Community Engagement and Local Service
Through several community engagement programs, MIT students can work with a K–12 science classroom, serve as a mentor to adolescents in math and science, or teach a child to read. The PSC maintains the online MIT Outreach Directory of outreach programs offered throughout the Institute, many of which share MIT’s research endeavors with the public. Additionally, the PSC offers programs such as the Freshman Urban Program, Giving Tree, and ReachOut that connect the MIT community to needs of the broader Cambridge/Boston community.

In addition, through the Four Weeks for America program, students work with Teach for America teachers during the month of January to help them develop innovative ways to teach science and math to students. PSC staff also advise about volunteer opportunities, service group management, grants and proposal writing, and other areas that help MIT students, staff, and faculty participate in service to the local community.
Office of Government and Community Relations
Since its founding, MIT has maintained a commitment to serving the local community as both a resource for education and technology and as a good neighbor. Through the Office of Government and Community Relations (OGCR), MIT works collaboratively with dozens of Cambridge nonprofits that address local challenges and opportunities such as meeting the needs of underserved populations, youth programs, and environmental sustainability. The Institute supports these organizations by providing direct financial support as well as in-kind resources including facility use, faculty and staff expertise, and volunteer engagement. In addition, OGCR collaborates with the MIT Public Service Center and MIT Community Giving to oversee the MIT Community Service Fund (CSF). The CSF provides support for nonprofits where MIT volunteers are at work and encourages the creation of new community service projects by providing grants to MIT affiliates.

Service to the community is not just centralized in one office at MIT—the Institute’s various Departments, Labs and Centers have a diverse array of programs that support our host community.

Office of Digital Learning
The Office of Digital Learning, through its Strategic Educational Initiatives unit, is taking the lead in developing collaborations with community colleges. These projects include curriculum development in areas such as advanced manufacturing and entrepreneurship, and online learning using edX and other MIT technologies. The design of these projects reflects the MIT mens et manus philosophy of blending online/virtual instruction with hands-on learning. With funding from the federal Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant Program, ODL is working with 15 Massachusetts community colleges to develop blended courses in advanced manufacturing. Other collaborations are in the proposal or design stages.

Abdul Latif Jameel Poverty Action Lab (J-PAL)
The Abdul Latif Jameel Poverty Action Lab (J-PAL) is a global network of over 100 researchers from leading universities who use randomized evaluations to answer critical questions in the fight against poverty. J-PAL was founded on the belief that development programs can be made more effective, creating positive change in the lives of the poor, if policymakers have access to rigorous scientific evidence of what works.

J-PAL has a three-part strategy to ensure that policy is informed by rigorous evidence: (1) increase scientific evidence on poverty reduction through randomized evaluations, (2) promote a culture of evaluations through training and facilitating the use of evidence in the policymaking process, and (3) encourage the use of rigorous research findings in the design and scale-up of poverty alleviation programs through outreach, promotion, and technical advising.

J-PAL was founded at MIT in 2003 as a research institute in the Department of Economics. In addition to its headquarters at MIT, J-PAL has expanded to six regional offices hosted by local universities in Africa (University of Cape Town), Europe (Paris School of Economics), Latin America (Pontificia Universidad Católica de Chile), North America (MIT), South Asia (Institute for Financial Management & Research), and Southeast Asia (University of Indonesia). Within each region, J-PAL works across seven program areas, including Agriculture, Education, Environment & Energy, Finance & Microfinance, Health, Labor Markets, and Political Economy & Governance.
Research
J-PAL affiliates have conducted more than 500 randomized evaluations in over 50 countries. Recent research by J-PAL affiliates includes: an evaluation by Olken (MIT), Onishi (World Bank), and Wong (World Bank) that found that community block grants improved health and education in Indonesian villages, and adding performance incentives sped up improvements in health; an evaluation of the impact of third-party environmental audits on truth-telling and pollution levels among industrial firms in India by Duflo (MIT), Greenstone (MIT), Pande (Harvard), and Ryan (Harvard); and an evaluation of the impact of household water connections on time use, social conflict, and mental well-being in urban Morocco by Devoto (J-PAL Europe), Duflo (MIT), Dupas (Stanford), Pariente (UC Louvain), and Pons (MIT).

Capacity Building
J-PAL also aims to increase the capacity of governments, NGOs, and other organizations to produce their own evidence to inform effective development policy. J-PAL has equipped more than 1,600 practitioners with the expertise to conduct their own rigorous evaluations through training courses and joint research projects.

Policy Outreach
J-PAL affiliates and staff analyze and disseminate research results and build partnerships with policymakers to ensure that policy is informed by evidence and to scale up programs that are found to be highly effective. Such programs have included school-based deworming, remedial education, free insecticidal bednets, dispensers for safe water, police skills training for police, conditional community block grants, and improved distribution of subsidized rice. Programs that were found to be successful by J-PAL affiliates and then scaled up in different parts of the world have reached over 160 million people.

Local Programs

Amphibious Achievement
Amphibious Achievement is an MIT student group that mentors high school students in the Boston-Cambridge area in both athletics and academics. Under the guidance of MIT student coaches/tutors, Amphibious Achievers train to row and swim competitively while also working on critical reading techniques, math problem solving, and grammar comprehension in an SAT-based curriculum.

http://amphibious.mit.edu/

Cambridge Science Festival
The annual Cambridge Science Festival, the first of its kind in the United States, is a celebration showcasing Cambridge as an internationally recognized leader in science, technology, engineering, and math. The festival is presented by the MIT Museum in collaboration with the City of Cambridge, community organizations, schools, universities, and businesses. A multifaceted, multicultural event held every spring, the festival makes science accessible, interactive, and fun, while highlighting the impact of science on all our lives.

CityDays Campaign
The CityDays Campaign is a six-part, year-long campaign. Each part of the campaign comprises a one-day service event with participants from the entire MIT community that work to serve a local organization for several hours. The PSC offers two events in the fall semester, one during January, two more during the spring, and then a special all staff event during the summer. These events will attract around 600 volunteers completing over 1,000 hours of volunteer service. Volunteers help to maintain green spaces in Cambridge and Boston, prepare materials and clothing for low-income children, and serve meals to individuals experiencing homelessness, among many other activities.
Edgerton Center—K–12 Programs
The Edgerton Center continues the learning-by-doing legacy of “Doc” Edgerton. The Center’s K–12 programs educate, inspire, and motivate kindergarten through 12th grade students through hands-on science and engineering challenges with the aim of increasing students’ curiosity and desire to pursue these fields in their future. Concentrating in the Greater Boston area, with selected out-of-state and foreign endeavors, the Edgerton Center’s multifaceted approach supports over 150 on-campus classroom workshops annually, intensive summer programs, innovative curriculum and professional development workshops for teachers. The Edgerton Center instructors mentor faculty and students in local public schools as well. In all aspects of these programs, MIT students are closely involved. All of the programs are provided at no or minimal cost.

Educational Studies Program
Founded by students in 1957, the MIT Educational Studies Program (ESP) shares knowledge and creativity with local high school students in the Boston, Cambridge, and MIT communities. Through an extensive offering of academic and non-academic classes, ESP is dedicated to providing a unique, affordable educational experience for motivated middle school and high school students. ESP courses are developed and taught by MIT students, alumni, faculty, and members of the community.

http://esp.mit.edu/

Freshman Urban Program
The Freshman Urban Program is a freshman pre-orientation program that introduces students to MIT and the surrounding community through service activities and discussion of urban issues. Projects have included sorting food at food banks, working with low-income students in math and science, maintaining Fenway field, along with serving many additional local organizations. Community service combined with reflection and urban exploration provide incoming students with opportunities to meet people, get involved in the community, and to learn about themselves with respect to the MIT and greater community.

Giving Tree
The MIT Giving Tree allows students, alumni, faculty, staff, and friends to provide gifts to local children and families each holiday season. The MIT Public Service Center works with several campus groups, along with hundreds of individuals across campus to collect gifts for 12 local agencies serving low-income children. This program provides MIT a means to expand our ethic of caring to local children and families.

World Programs
D-Lab
MIT D-Lab is building a global network of innovators to design and disseminate technologies that meaningfully improve the lives of people living in poverty. The program’s mission is pursued through interdisciplinary courses (19 developed to date, about a dozen offered each year), technology development, and community initiatives, all of which emphasize experiential learning, real-world projects, community-led development, scalability, and impact assessment. Founded by Amy Smith, Senior Lecturer in Mechanical Engineering, D-Lab has developed a range of technologies and processes including community water testing and treatment systems, human powered agricultural processing machines, medical and assistive devices for global health, and clean-burning cooking fuels made from waste. All D-Lab classes and projects are connected to communities around the world in countries including Brazil, Nicaragua, Honduras, Guatemala, El Salvador, Haiti, Ghana, Lesotho, Nigeria, Tanzania, Uganda, Zambia, Cambodia, Nepal, India, and the Philippines.

http://d-lab.mit.edu/
Comprehensive Initiative on Technology Evaluation

The Comprehensive Initiative on Technology Evaluation (CITE) has developed a rigorous methodology for evaluating technological solutions to challenges in the developing world to help donors and policymakers identify and invest in the best of these solutions. CITE researchers investigate how products behave or might behave prior to their large-scale implementation, and even prior to their design. The multidisciplinary approach developed by CITE is user and context-driven, focusing on three main evaluation components: suitability, scalability and sustainability. The first CITE evaluation focused on technical and user testing of solar lighting options available in the Uganda. The second evaluation is located in India and focused on water filters. CITE is a five-year program funded by USAID’s Global Development Lab and led by D-Lab in partnership with the Department of Urban Studies and Planning.

http://d-lab.mit.edu/cite/

International Development Innovation Network

The International Development Innovation Network (IDIN) is building a diverse, international, network of innovators to define development problems, prototype solutions to these challenges, perform comparative evaluations, move the most promising solutions forward, and incubate ventures to disseminate the solutions. At the core of IDIN is a network of nearly 400 inventors, technologists, and social entrepreneurs from almost 50 countries around the world. IDIN is supporting and building this network through hands-on design summits, focused entrepreneurship training modules, micro-grants, and networking within and outside the network. IDIN also includes research, monitoring, and evaluation functions to document and assess its work to ensure that best practices are identified and supported. In addition to MIT, IDIN consortium institutions include Olin College of Engineering, Colorado State University, University of California-Davis, Kwame Nkrumah University of Science and Technology (Ghana), and the National Technology Business Center (Zambia).

http://d-lab.mit.edu/idin/

D-Lab Scale-Ups

D-Lab Scale-Ups was established in 2011 to identify and support technologies with potential for wide-scale poverty alleviation. The program includes an accelerator for MIT social entrepreneurs, a technical assistance program, research and development, and collaboration with industry. As of 2014, the Scale-Ups Fellowship program has supported 16 social entrepreneurs working in sectors including health care, waste recycling, water sanitation, solar energy, and agriculture. The Scale-Ups fellows have launched ventures in less-industrialized markets in Africa, Central and South America, and Asia. Scale-Ups’ technical assistance program for agricultural waste charcoal briquette enterprises in East Africa is facilitated by the Harvest Fuel Initiative, a collaborative effort by D-Lab and New York-based nonprofit The Charcoal Project. In the fall of 2014, D-Lab Scale-Ups will launch the Practical Impact Alliance at MIT to promote collaborative action and shared learning among corporations, academic institutions, social ventures, and nongovernmental organizations in order to scale market-driven poverty solutions worldwide.

http://d-lab.mit.edu/scale-ups/overview/

Legatum Center for Development and Entrepreneurship

The Legatum Center for Development and Entrepreneurship at MIT was founded on the belief that economic progress and good governance in low-income countries emerge from entrepreneurship and innovations that empower ordinary citizens. The center administers a highly competitive fellowship program for MIT graduate students who intend to launch innovative and inclusive for-profit enterprises in developing countries. In addition to supporting the Legatum Fellows, the Legatum Center aims to catalyze entrepreneurship for broad-based prosperity by administering programs including case writing, research, articles, lectures, conferences, and seed grants.

http://legatum.mit.edu/

International Development Grants

These grants support international development projects that involve MIT students. Faculty, students, and other MIT community members can use them to cover materials, travel, and other expenses in projects that serve communities in developing regions.
Selected Projects

Satellite imagery can aid development projects
Projects that target aid toward villages and rural areas in the developing world often face time-consuming challenges, even at the most basic level of figuring out where the most appropriate sites are for pilot programs or deployment of new systems such as solar-power for regions that have no access to electricity. Often, even the sizes and locations of villages are poorly mapped, so time-consuming field studies are needed to locate suitable sites.

Now, a team of graduate students at MIT and a social-service group of data scientists have come up with a way of automating parts of that evaluation process, by developing software that can identify houses and even types of houses from readily-available satellite imagery—potentially saving considerable time that would otherwise be spent sending teams from village to village. Their findings have now been published in the journal *Big Data*.


MIT-USAID program releases pioneering evaluation of solar lanterns
When a person lives on less than $2 a day—as some 2.7 billion people around the world do—there isn’t room for a product like a solar lantern or a water filter to fail.

It’s a challenge development agencies, nongovernmental organizations, and consumers themselves face every day: With so many products on the market, how do you choose the right one?

MIT researchers have released a report that could help answer that question through a new framework for technology evaluation. Their report—titled “Experimentation in Product Evaluation: The Case of Solar Lanterns in Uganda, Africa”—details the first experimental evaluations designed and implemented by the Comprehensive Initiative on Technology Evaluation (CITE), a U.S. Agency for International Development (USAID)-supported program led by a multidisciplinary team of faculty, staff, and students.

CITE’s framework is based on the idea that evaluating a product from a technical perspective alone is not enough, according to CITE Director Bishwapriya Sanyal.

“There are many products designed to improve the lives of poor people, but there are few in-depth evaluations of which ones work, and why,” Sanyal says. “CITE not only looks at suitability — how well does a product work?—but also at scalability—how well does it scale?—and sustainability—does a product have sticking power, given social, economic, and environmental context?”

http://newsoffice.mit.edu/2015/solar-lanterns-evaluation-0120

Boosting science, math, technology, and ethics in Tibetan communities
To many Westerners, science, monks, and technology may not be an obvious trio. But to Tenzin Priyadarshi and others at MIT’s Dalai Lama Center for Ethics and Transformative Values, they are a means of improving the lives of Tibetans dispersed throughout India and elsewhere.

The program, called the Science, Monks and Technology Leadership Program, was launched in 2013 to help members of the Tibetan diaspora find solutions to the challenges they face in some of India’s poorest regions. For example, the program has produced the first of a planned series of science centers—a simple concrete building outfitted with computers and online access—in an area where most people lack electricity or piped water. There, students and monks will be able to learn from materials such as lectures on MIT’s OpenCourseWare (with added Tibetan subtitles).

“We’ll be using that as a hub for testing out some of the models,” Priyadarshi says — efforts such as solar- or bicycle-powered electricity, and creating awareness about sustainable farming and improved water systems. The centers will provide courses, serve as hubs “where people can try out things,” Priyadarshi says, and provide continuing education to science teachers, with each center serving 30 to 40 nearby schools, he says.
