The Briefing Book is researched and written by a variety of MIT faculty and staff, in particular the members of the Office of the Provost’s Institutional Research group, Industrial Liaison Program, Student Financial Services, and the MIT Washington Office.

**Executive Editors**
Maria T. Zuber, Vice President for Research  
mtz@mit.edu
William B. Bonvillian, Director, MIT Washington Office  
bonvill@mit.edu

**Editors**
Shirley Wong  
shirleywong@mit.edu
Lydia Snover, to whom all questions should be directed  
lsnover@mit.edu
MIT Senior Leadership

President
L. Rafael Reif

Director, Lincoln Laboratory
Eric D. Evans

Chairman of the Corporation
Robert B. Millard

Dean, School of Architecture and Planning
Hashim Sarkis

Provost
Martin A. Schmidt

Dean, School of Engineering
Ian A. Waitz

Chancellor
Cynthia Barnhart

Dean, School of Humanities, Arts, and Social Sciences
Melissa Nobles

Executive Vice President and Treasurer
Israel Ruiz

Dean, School of Science
Michael Sipser

Vice President for Research
Maria T. Zuber

Dean, Sloan School of Management
David C. Schmittlein

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Associate Provost
Karen Gleason

Chancellor for Academic Advancement
W. Eric L. Grimson

Associate Provost
Philip S. Khoury

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Associate Provost
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Director of Libraries
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Julie Lucas

Institute Community and Equity Officer
Edmund Bertschinger

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Dean for Graduate Education
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Dean for Undergraduate Education
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Dean for Student Life
Chris Colombo

Vice President for Information Systems and Technology
John Charles

Dean of Digital Learning
Sanjay Sarma

Vice President for Finance
Glen Shor
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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.

**Staff**
Director
William B. Bonvillian

Assistant Director
Philip H. Lippel

Senior Policy Advisor
Kate Stoll

**Address**
MIT Washington Office
820 First Street, NE, Suite 610
Washington, DC 20002

**Telephone Number**
202.789.1828

**Fax Number**
202.789.1830

**Website**
http://dc.mit.edu/
Contents

Section 1: Facts and History
- Fields of Study 9
- Digital Learning 11
- Research Laboratories, Centers, and Programs 12
- Academic and Research Affiliations 13
- Education Highlights 14
- Research Highlights 16
- Faculty and Staff 21
- Faculty 30
- Researchers 30
- Postdoctoral Scholars 32
- Awards and Honors of Current Faculty and Staff 33

Section 2: Major MIT Initiatives
- National Policy Initiatives 37
- Research Initiatives 38

Section 3: Students
- Undergraduate Students 47
- Graduate Students 49
- Degrees 50
- Alumni 51
- Undergraduate Financial Aid 52
- Graduate Financial Aid 53

Section 4: Campus Research
- Research Support 59
- Campus Research Sponsors 60
- Department of Defense 62
- Department of Energy 64
- National Institutes of Health 66
- NASA 68
- National Science Foundation 70
- Other Federal Agencies 72
- Nonprofit Organizations 74

Section 5: Lincoln Laboratory
- Research Expenditures 79
- Authorized Funding 81
- Lincoln Laboratory’s Economic Impact 82
- Air and Missile Defense Technology 83
- Communication Systems 84
- Cyber Security and Information Sciences 85
- Intelligence, Surveillance, and Reconnaissance Systems and Technology 86
- Tactical Systems 86
- Space Control 87
- Advanced Technology 88
- Homeland Protection 89
- Aviation Research 90
- Advanced Research Portfolio 91
- Lincoln Laboratory Staffing 92
- Test Facilities and Field Sites 93
Section 1
Facts and History

Fields of Study 11
Digital Learning 12
Research Laboratories, Centers, and Programs 13
Academic and Research Affiliations 14
Education Highlights 16
Research Highlights 21
Faculty and Staff 30
Faculty 30
Researchers 32
Postdoctoral Scholars 33
Awards and Honors of Current Faculty and Staff 34
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 long-standing 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
Data, Systems, and Society
Electrical Engineering and Computer Science
Institute of Medical Engineering and Science
Materials Science and Engineering
Mechanical Engineering
Nuclear Science and Engineering

School of Humanities, Arts, and Social Sciences
Anthropology
Comparative Media Studies/Writing
Economics
Global Studies and Languages
History
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
Computer Science and Molecular Biology
Humanities
Humanities and Engineering
Humanities and Science

Interdisciplinary Graduate Programs
Computation for Design and Optimization
Computational and Systems Biology
Computer Science and Molecular Biology
Harvard-MIT Health Sciences and Technology Program
Joint Program with Woods Hole Oceanographic Institution
Leaders for Global Operations
Microbiology
Operations Research
Polymers and Soft Matter
Supply Chain Management
Design and Management (Integrated Design and Management & 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.** Digital learning technologies enable students to do more outside of the class, so that class time can focus on deeper discussion, hands-on experiments and other forms of active learning. Digital technology can deliver lecture content, provide students rapid feedback on their understanding and even adaptive hints to foster learning, and foster more active reading and discussion through annotation tools. Digital platforms can also augment understanding, via visualizations, simulations and games. These technologies provide flexibility in course delivery, allowing more modularization and enabling students to access content anytime, anywhere; this is especially helpful for students who seek to access material in courses that are not offered every year. 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 to harness the Institute’s educational technology resources to ensure that MIT remains at the forefront of developments like these. ODL integrates formerly independent organizational units related to digital learning to focus on these strategic priorities:

- Support MIT faculty and students in bold experiments to enhance our residential education and provide resources for those who are interested in exploring how they might do so.
- Facilitate research on how people learn and on new technologies that might improve understanding, retention and application.
- Provide platforms for technological advances in digital education.
- Partner with companies, universities, governments and organizations that wish to develop new learning capabilities and enhance the competencies of their workforce, students and citizens.
- Extend MIT’s knowledge and classrooms to the world.

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 Archaeological Materials
Center for Biomedical Engineering
Center for Collective Intelligence
Center for Computational Engineering
Center for Computational Research in Economics and Management Science
Center for Energy and Environmental Policy Research
Center for Environmental Health Sciences
Center for Global Change Science
Center for International Studies
Center for Materials Science and Engineering
Center for Transportation and Logistics
Clinical Research Center
Computer Science and Artificial Intelligence Laboratory
Concrete Sustainability Hub
Deshpande Center for Technological Innovation
Division of Comparative Medicine
Initiative on the Digital Economy
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
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
Legatum Center for Development and Entrepreneurship
Martin Trust Center for MIT Entrepreneurship
Materials Processing Center
McGovern Institute for Brain Research
Media Lab
Microsystems Technology Laboratories
MIT Center for Art, Science, and Technology
MIT Energy Initiative
MIT Kavli Institute for Astrophysics and Space Research
MIT Professional Education
MIT Program in Art, Culture and Technology
MIT Sea Grant
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
Technology and Development Program
Transportation@MIT
Whitehead Institute for Biomedical Research
Women’s and Gender Studies Program

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.

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/nucc/

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/

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 109 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.
http://www.haystack.mit.edu/hay/neroc.html

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 106 for more information about SMART.
http://smart.mit.edu/

MIT Skoltech Initiative
The MIT Skoltech Initiative is a multi-year collaboration between the Skolkovo Foundation, the Skolkovo Institute of Science and Technology (Skoltech), and MIT to help conceive and launch a new private graduate research university focused on a small number of key global themes and designed to stimulate the development of a robust and economically impactful innovation ecosystem in Russia. See page 106 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. Nineteen 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 111.

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 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.

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

1990 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 establishes the Office of Digital Learning to harness the Institute’s digital learning resources, creating more integration and coordination among formerly independent organizational units related to educational technology.

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.

2012 MIT announces the launch of the Institute for Medical Engineering and Science (IMES). IMES brings together research and education efforts at the nexus of engineering, science, and clinical medicine to advance human health.

2013 The School of Engineering and Lincoln Laboratory launch Beaver Works. This initiative facilitates project-based learning by leveraging partnerships between faculty and students at MIT and practicing engineers at Lincoln Laboratory to promote collaborative research and to enable the fabrication of prototype systems. The initiative’s signature collaboration is the Beaver Works capstone project in areas such as unmanned aerial vehicles, small satellites, autonomous underwater systems, energy systems, cybersecurity, communications, big data analytics, and advanced devices.

2013 OCW inaugurates “OCW Educator” with the first “This Course at MIT” page. This feature offers educational ideas, practices, and pedagogical expertise from MIT faculty in order to inspire teachers around the world with innovations that they may use in their own teaching.

2014 MITx on edX registers its one-millionth learner on May 27, 2014.

2014 The Office of Digital Learning pilots the MITx Global Entrepreneurship Bootcamp, an innovative “blended learning” program that combines online education with an intensive, immersive one-week on-campus experience.

2014 MIT Professional Education, in cooperation with the Office of Digital Learning and edX, begins offering online courses designed specifically for industry and active professionals. Based on research in areas ranging from big data, cybersecurity, and entrepreneurship, these courses enable MIT to disseminate knowledge at scale to professionals around the world, in areas critical to industry. The first course on big data enrolled more than 7,000 paid enrollees from over 100 countries.
Facts and History

2015 SuperUROP, an amplified version of the Undergraduate Research Opportunities Program, is launched in the School of Engineering. First conceived and implemented in 2012 under the leadership of the Department of Electrical Engineering and Computer Science, SuperUROP is a year-long program that enables students to tackle complex problems and affords them the time, training, resources, and guidance necessary for deep scientific and engineering inquiry.

2015 MIT creates the MIT-Woodrow Wilson Academy of Teaching and Learning to advance pre-K through 12 education by combining MIT’s “mind and hand” approach to learning with recent breakthroughs in cognitive science and digital learning. The program develops STEM teachers and school leaders around the world.

2015 The Residential MITx platform hosts its 100th course. Nearly 90% of MIT undergraduates have participated in one or more courses that use the platform.

2015 The Institute for Data, Systems, and Society (IDSS) is launched. A collaboration among all five of MIT’s schools, IDSS brings together researchers working in the mathematical, behavioral, and empirical sciences to capitalize on their shared interest in tackling complex societal problems.

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 U.S. 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 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 received the National Medal of Science for this pioneering work in 1995.

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 Explo- rations 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 huddles 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 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, graduate student Joseph Franses, and former 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.

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 the 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.
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.

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.

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.

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.

A new steelmaking process developed by 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.

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.

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.

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.

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, 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 Shamyook 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.

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 68 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 68 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.
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>
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<tr>
<td>Support staff</td>
<td>1,538</td>
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<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>
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</tr>
<tr>
<td><strong>Total campus faculty and staff</strong></td>
<td><strong>11,843</strong></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>
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</thead>
<tbody>
<tr>
<td>Professors</td>
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<td>65</td>
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<tr>
<td>Associate professors</td>
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<td>19</td>
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<tr>
<td>Assistant professors</td>
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<td>16</td>
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<tr>
<td><strong>Total</strong></td>
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<td>Male</td>
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<tr>
<td>Female</td>
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<td>22</td>
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</tbody>
</table>

See page 48 for a chart of faculty and students from 1865–2015.

Seventy-six percent of faculty are tenured.

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><strong>1,021</strong></td>
<td><strong>100</strong></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 92 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.
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.

Elapsed Years at MIT of Campus Research Staff and Scientists, 2014–2015 (Senior Researchers, Principal Researchers, and Research Scientists and Technicians)
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><strong>Total underrepresented minorities (URM)</strong></td>
<td><strong>35</strong></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><strong>Total</strong></td>
<td><strong>541</strong></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%

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>

Years at MIT of Postdoctoral Scholars, 2014–2015

- **Male**
- **Female**

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>146</td>
<td>American Academy of Arts and Sciences Member</td>
</tr>
<tr>
<td>96</td>
<td>American Association for the Advancement of Science Fellow</td>
</tr>
<tr>
<td>11</td>
<td>American Philosophical Society Member</td>
</tr>
<tr>
<td>87</td>
<td>American Physical Society Fellow</td>
</tr>
<tr>
<td>21</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>62</td>
<td>Guggenheim Fellow, John Simon Guggenheim Memorial Foundation</td>
</tr>
<tr>
<td>19</td>
<td>HHMI Investigator, Howard Hughes Medical Institute (HHMI)</td>
</tr>
<tr>
<td>54</td>
<td>Institute of Electrical and Electronics Engineers, Inc. Fellow</td>
</tr>
<tr>
<td>31</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>22</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>66</td>
<td>National Academy of Engineering Member, National Academies</td>
</tr>
<tr>
<td>79</td>
<td>National Academy of Sciences Member, National Academies</td>
</tr>
<tr>
<td>10</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>4</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

![Michael Stonebraker](Photo: M. Scott Brauer)

**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

![Alan Guth](Photo: Erica Ferrone Photography)

**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.”


![Robert Langer](Photo: M. Scott Brauer)
Section 2

Major MIT Initiatives

National Policy Initiatives 38
Research Initiatives 43
National Policy Initiatives
MIT has had major involvement in technology policy at the national level since before World War II, with MIT faculty and administrators frequently serving as advisors to national policymakers. A more formal “policy initiative” model is relatively new, having developed over the past decade. In 2005, incoming MIT President Susan Hockfield announced that MIT would create a major cross-disciplinary, cross-school initiative around energy, which led to MIT’s first major policy initiative effort. Additional initiatives have since been created to tackle other major science and technology issues with national and, often, global policy dimensions. These are inherently cross-disciplinary, drawing on a range of MIT expertise, from science and engineering to the social sciences, economics, and management. Some, such as energy, are ongoing. Others have had more defined, shorter-term goals. Major policy initiatives to date are described here.

Energy
The MIT Energy Initiative (MITEI) was formally launched in the fall of 2006, following the recommendations of the 2006 Report of the Energy Research Council regarding new approaches to multidisciplinary research, education across school and department boundaries, energy use on campus, and outreach to the policy world through technically grounded analysis. As described on page 45, the education component of MITEI has grown rapidly through the development of new academic materials and pathways. Simultaneously, MITEI has helped energy research at MIT grow by developing strategic alliances with companies across a broad range of energy-related businesses as well as by attracting government and philanthropic support.

MITEI is recognized as the first and the foremost campus-wide energy program at a U.S. academic institution. Its policy outreach component has similarly prospered, and now includes both core MITEI activities and those under the auspices of programs with many MITEI-affiliated faculty members (such as the Center for Energy and Environmental Policy Research (CEEPR) and the Joint Program on the Science & Policy of Global Change). MITEI, CEEPR, and the Joint Program each hold workshops at least annually which address technological, economic, and political aspects of energy and climate issues.

MITEI’s best-known policy products are the in-depth, multidisciplinary “Future of ...” studies, which are designed to inform future decisions regarding energy research, technology choices, and policy development. The most recent MITEI study, The Future of Solar Energy was released at the National Press Club on May 8, 2015 and continues to draw national attention. Now underway is The Utility of the Future: Preparing for a Changing Energy Sector. Additional studies are in the planning stages.

Convergence
“Convergence” is a term for the merging of distinct technologies, integrating disciplines, 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 at MIT implies a broad rethinking of how all scientific research can be conducted, to capitalize on a range of knowledge bases, from microbiology to computer science to engineering design. It is a new organizational model for innovation, taking the tools and approaches of one field of study and applying them to another, paving the way for advances in all fields involved. Just as engineering and physical sciences 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 the results from this reciprocal relationship at MIT. The following site documents the major convergence developments referenced below:

http://www.convergencerevolution.net/

MIT has been a leader in the Convergence revolution from the beginning, developing a widely cited whitepaper on the topic in 2011, entitled Third Revolution: Convergence of The Life Sciences, Physical Sciences And Engineering led by a faculty committee named by President Susan Hockfield, and chaired by Professors Phillip Sharp and Robert Langer. In parallel to the development of the report, MIT created its Koch Institute for Integrative Cancer Research, internally adopting the convergence research model, and
organizing its latest advanced research facility to include biologists, engineers and physical scientists working in close collaboration.

Support grew for this integrated research approach following the report, with the White House featuring a section on Fostering Convergent Science in its Blueprint For Action, released in January 2013, which included advancing the convergence approach among four goals for the year. In the spring of 2013, President Obama announced the BRAIN initiative (Brain Research through Advancing Innovative Neurotechnologies), a major public-private partnership consciously utilizing a convergence research approach, with federal participation by NIH, NSF, and DARPA complemented by contributions from companies, health systems, patient advocacy organizations, philanthropists, state governments, research universities, private research institutes, and scientific societies.

Five MIT faculty members were invited to attend the White House event, a larger delegation than from any other university. MIT Professor Emery Brown subsequently chaired the NIH Advisory Committee to the Director’s Working Group for the initiative.

At the AAAS Annual meeting in Chicago in February of 2014, Professor Phillip Sharp delivered the annual AAAS President’s Lecture on Convergence to a group of over 1000 scientists. In addition, former MIT President Susan Hockfield led a multi-hour convergence workshop at the meeting. AAAS later released a report summarizing the workshop findings.

The National Academies of Science has also provided leadership in the convergence effort. Its “Key Challenges in the Implementation of Convergence,” a workshop led by the Board on Life Sciences of the National Academies in September 2013 was co-chaired by former MIT President Hockfield and featured Professor Philip Sharp. A book from the National Academies Press, *Convergence—Facilitating Transdisciplinary Integration of Life Sciences, Physical Science, Engineering and Beyond*, summarizing the workshop findings was published in May. Meanwhile, in parallel, the Defense Advanced Research Projects Agency (DARPA) has been expanding its focus on convergence model research, forming a new Biological Technologies Office with a research portfolio in areas including biofabrication, neuroscience, and infectious disease, and leading DARPA’s participation in the BRAIN initiative. The White House has subsequently developed a new Precision Medicine Initiative, also organized on the convergence model utilizing big data and analytics to develop personalized medicine advances.

At MIT, convergence as a research model is now deeply anchored in many areas of life science advances, including work in quantum information studies of neurons, neuroscience and computing, synthetic biology, and cancer research.

**Advanced Manufacturing**

MIT leaders have played a major role in recent years in the design of national efforts to confront structural problems in the U.S. manufacturing sector, starting in 2011 with the MIT Production in the Innovation Economy study project. It continued until 2015 with MIT playing a strong leadership role in the President’s Advanced Manufacturing Partnership (AMP) which led to the development of a network of regional institutes to promote manufacturing innovation and other programatic efforts. On campus, these efforts helped to define an emerging campus initiative on innovation, and work on advanced manufacturing research, education, and outreach in the region.

MIT has also been participating in efforts to create new advanced manufacturing institutes, cost shared between federal and state governments and by industry. On July 26, 2015 a regional consortia including New York and Massachusetts firms and universities was competitively selected by federal officials to form an institute around integrated photonics, with MIT faculty leading technology development and workforce education segments of the project.
The AMP 1.0 report in 2012 led to the new network of advanced manufacturing institutes, modeled on the German Fraunhofer institutes. Fifteen institutes will be stood up by the end of 2016, funded at a half billion annually, matched by higher levels of industry and state cost-sharing.

The AMP 2.0 report was released in October 2014, making new recommendations supplementing AMP 1.0 on advanced manufacturing technology development strategies, collaborative R&D efforts across leading federal agencies, apprenticeship and training programs, and policies to support financing of production scale-up for advanced manufacturing processes and technologies. In addition to President Reif’s leadership role, Professor Van Vliet co-chaired the AMP 2.0 technology development workgroup, preparing manufacturing strategies on digital manufacturing, advanced materials for manufacturing, and sensors/measurement/process control areas. President Reif and Provost Schmidt led the AMP 2.0 Steering Committee, along with DOW CEO, Andrew Liveris, and the President’s National Economic Council Director, Science Advisor, and Commerce Secretary, in 2013–2014. MIT hosted the New England AMP 2.0 regional meeting in the Stata Center with over 200 leaders from area industries and universities participating. Senator Edward Markey and senior state and federal officials also attended.

The “Future Postponed”
Federal support is the primary mainstay of U.S. science research. As federal R&D funding has stagnated, new ways of explaining to policy makers the central societal need for science is required. The MIT report The Future Postponed: Why Declining Investment in Basic Research Threatens a U.S. Innovation Deficit, released in April of 2015, is a new way of explaining science and is designed to be accessible to policymakers. The Future Postponed explains the critical importance of federal investment in science research to grow the economy, develop better therapies and cures, stay competitive, and solve global challenges.
The MIT Committee to Evaluate the Innovation Deficit, named in October 2014 comprised of 30 MIT faculty and researchers from across all schools at MIT, selected and wrote case studies of 15 vital areas of science and engineering from infectious disease, to batteries, Alzheimer’s, cybersecurity, catalysis, economics and plant science. The report is not a list of priorities in science research, but rather a short set of illustrative examples from a much longer list of critical fields worthy of investment.

The science community has tried to tell the stories of how past investments in research have paid off in today’s technologies—like GPS, MRI, and the Google search engine—but has not fully told how research cutbacks today will affect the science of tomorrow. The “Future Postponed” report explores the remarkable technology opportunities that lie ahead and the science needed to get there, all fully vetted by a faculty review board, but written in short two or three page case studies that are highly accessible to non-scientist readers. It’s a vision of the future of innovation in America and a call for sustained support for research.

The report has gained national press attention in such forums as the Wall Street Journal, the New York Times, Reuters, the Los Angeles Times, and others. A group from the faculty committee, led by Professor Marc Kastner, former Dean of Science, held a forum hosted by the AAAS and briefed Congressional staff, White House staff, and other national stakeholders during a Washington DC visit on April 27th.

A second national phase of the report is now beginning, with Professor Kastner leading an advisory committee of noted scientists from outside MIT developing additional case studies. The full report is at http://dc.mit.edu/innovation-deficit and additional case studies are posted online at www.futurepostponed.org.

Innovation

In October 2013, President Reif announced an “innovation initiative” at MIT, which was followed by a report on the proposed project in December 2014, http://innovation.mit.edu/sites/default/files/images/MIT_Innovation_Initiative_PreliminaryReport_12-03-14.pdf. The initiative has primarily focused on MIT itself. As summarized on its website (http://innovation.mit.edu/about) the report emphasizes:

- Capability-building Programs: Growing existing education opportunities while creating a select few new programs of interest to MIT students and faculty
- Convening Infrastructure: Expanding maker and collaborative spaces across campus and creating digital tools that connect them into a unified campus
- Communities: Linking the MIT community more deeply with corporations, governments, and innovation hubs in Cambridge and around the world
- Lab for Innovation Science and Policy: an organized effort to develop the ‘science of innovation’ and evidence-base to inform both internal and external program design

In May 2015, President Rafael Reif announced a new innovation programatic focus in a Washington Post oped (http://newsoffice.mit.edu/2015/reif-op-ed-washington-post-0524). President Reif emphasized the need for regional and national policy elements to fill a gap he identified in the national innovation system. He noted that startups in non-IT fields face major challenges in scaling up to a point where their technologies are demonstrated, tested and de-risked, and placed in range of follow-on financing mechanisms. Calling for new innovation “orchards” and “accelerators,” a team at MIT is now exploring relevant models nationwide, and considering new innovation institutions to fill this gap that could be implemented by MIT and regional partners in Massachusetts.
Online Education
MIT’s pioneering support for online education has been in the national spotlight since the announce-
ment, in 2001, that the institute would make materials from all its courses freely available through Open-
CourseWare (OCW). Now part of the Office of Digital Learning (ODL), OCW has delivered lecture notes,
exams, and videos from over 2000 MIT courses to 175 million learners and educators. In May 2012, building
off the success of OCW and extending a tradition of educational innovation as old as the institute itself,
MIT joined together with Harvard University to create edX. Massively Open Online Courses are available via
the edX platform to anyone with Internet access. In
the first three years of operation, nearly half a million
learners have received certificates of completion
for courses offered by MIT and edX partners institu-
tions, including 50+ courses to date developed and
produced by ODL under the MITx nameplate.

The policy aspects of MIT’s digital learning initia-
tive came into focus with President Rafael Reif’s
announcement, in April 2013, of an Institute-wide
Task Force on the Future of MIT Education, charged
with capturing an integrated understanding of how
online access is changing teaching and learning. The
task force looked at impacts on our own campus and
beyond, and began to envision how future tech-
nologies and models can spark innovation in higher
education. Following the release of the task force’s
final report (http://bit.ly/1JSkNJM) in August 2014,
co-chairs Professor Sanjay Sarma and Professor
Karen Wilcox assumed the leadership of a study
of the national policy aspects and implications of
online education, with support from the Carnegie
foundation. This Online Education Policy Initiative
(OEPI) is exploring teaching pedagogy and efficacy,
institutional business models, and global educational
engagement strategies. It is scheduled to produce a
report on these issues in early 2016, which policy-
makers and leaders in education can use to deepen
the public discourse surrounding online learning and
to encourage productive discussion about the future
of higher education in the U.S. and globally. Impor-
tant input to the OEPI was obtained through a May
2015 workshop, sponsored by the National Science
Foundation, which brought fifty practitioners from
the learning science and online learning technology
communities together to discuss emerging ideas
about online pedagogy.

MIT’s senior leaders continued to take a national role
in the education initiative in 2014–2015, as shown in
the following examples. President Reif and Harvard
President Drew Faust hosted an online education
summit in Cambridge in April, with guests including
senior officers from colleges and universities from
across the country and leading academics in the field.
Under-Secretary of Education Ted Mitchell joined
Presidents Reif and Faust in an opening night discus-
sion of online learning on and off campus, moder-
ated by John Hockenberry, which was later broadcast
nationally on PRI’s “The Takeaway.” At the December
2014 White House College Opportunity Summit,
Chancellor Barnhart presented a commitment to
expand the use of edX courses to help develop
a cadre of high school science, technology, engi-
neering, and mathematics teachers skilled in the use
of educational technologies. These teachers can then
in turn better prepare their own students to transi-
tion into college and succeed academically along the
path to STEM careers.
Research Initiatives

Cybersecurity Initiatives

In 2015, MIT launched three campus-wide cybersecurity efforts aimed at addressing the technical, regulatory and managerial aspects of cybersecurity. The three initiatives: MIT Cybersecurity Policy Initiative, Cybersecurity@CSAIL, and 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.

MIT Cybersecurity Policy Initiative

MIT Cybersecurity Policy Initiative’s goal is to create a new field that will help governments and other responsible institutions create public policy frameworks that will increase the trustworthiness of the interconnected digital systems that will be the foundation of the future flourishing of our societies and on which we are already inexorably dependent. This campus wide initiative, housed in CSAIL, has already produced important research results contributing to current debates on the security of new electronic surveillance proposals. Working with colleagues from around the world, the initiative produced a paper, that has been widely cited at several legislative hearings in the U.S. Senate and reported in the world press. This paper analyzes security risks of new wiretapping proposals propounded by law enforcement agencies in the United States and the United Kingdom. Additionally, as part of the Initiative’s mission to train a new generation of technology policy leaders, in the spring of 2015, Initiative leaders ran an experimental course jointly with Georgetown Law School on privacy technology and legislation. The course gave students a high intensity introduction to privacy law and associated computer systems design questions. In 2015–16, initiative faculty are planning to organize a series of workshops on topics such as critical infrastructure security threats, cyberwar norms, global electronic surveillance technical and human rights risks, and cyber insurance markets.

Cybersecurity@CSAIL

Cybersecurity@CSAIL launched in 2015 with 5 founding industrial partners, the goal of CyberSecurity@CSAIL is to identify and develop technologies to address the most significant security issues confronting organizations in the next decade. Presently, approaches to system security do not give overall security guarantees, but rather attacks are fought individually—“patch and pray” style. CyberSecurity@CSAIL aims to provide an integrated and formal approach to the security of systems, combining design and analysis methods from cryptography, software and hardware. Cybersecurity@CSAIL’s approach includes three key elements: collaborate closely with industry for input to shape real-world applications and drive impact; approach the problem from a multidisciplinary perspective; and create a test-bed for our industry partners to implement and test our tools as well as have our researchers test tools developed by our partners.

MIT Sloan’s Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity (IC)³

MIT Sloan’s Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity (IC)³ addresses the important 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 (such as: ExxonMobil, Schneider Electric, State Street Bank), looks to address issues, such as cyber risk analysis, return on cybersecurity investment, application of cybersafety models, incentives for more effective information sharing, establishing a better organizational cybersecurity culture, methods for disrupting the cybercrime ecosystem, and metrics and models to better protect organizations.  

http://ic3.mit.edu
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 natural and social sciences, engineering, management, policy, and the humanities to help drive the kind of progress required in time to make a difference.

MIT is already a powerhouse of environmentally oriented research, education, 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 launch in September.

Education—both curricular and experiential—is integral to ESI’s mission. Understanding the complexity of human and natural systems and the essential relationship between environmental quality and human welfare is increasingly important for professionals and scholars in a diverse array of fields. ESI’s educational role is to provide integrative, multi-disciplinary opportunities for MIT students to develop their capacity as leaders in environment and sustainability. ESI’s Education Committee, composed of faculty, staff and students, is already at work advancing this agenda. A five-year grant from the Dirk (’75) and Charlene (’79) Kabcenell Foundation is supporting the development of a new Institute Minor in Environment and Sustainability.

http://environmentalsolutions.mit.edu/

Abdul Latif Jameel World Water and Food Security Lab

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 addresses 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 develops 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, spearheads 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 are 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 also seeks 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 supports 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) plays an important catalytic role in accelerating responses to the many challenges facing our global energy system. MITEI supports energy research teams across the Institute by bringing them together with government and industry to analyze challenges and develop solutions. MITEI also leads Institute energy education efforts and delivers comprehensive analyses for policy makers. Its accomplishments are enabled through the investment of member companies, government sponsors, and donors. From these funding sources, MITEI has raised more than $585 million to date to support MIT and MITEI Research, Education, and Outreach programs.

MITEI is an Institute-wide initiative that, in its depth and breadth, is without peer at U.S. academic institutions. MITEI-sponsored researchers are developing cutting-edge solutions and bringing new technologies to the marketplace. MITEI 2015 accomplishments include the acquisition of eight new members, the launch of two new consortia, and the release of The Future of Solar Energy, the newest in the series of “The Future of…” studies.

MITEI members have sponsored more than 800 projects, many involving collaborations between MIT researchers and member researchers. Nearly 30 percent of the MIT faculty is engaged with MITEI’s programs.

The MITEI Seed Fund Program supports innovative early-stage research projects that address energy and related environmental issues. Including 2015 grants, the MITEI Seed Fund Program has supported a total of 140 energy-focused research projects representing nearly $17.4 million in funding over the past eight years. The program encourages researchers from throughout MIT’s five schools to collaborate in exploring new energy-related ideas, and attracts a mix of established energy faculty as well as many who are new to the field or to MIT.

More than two-thirds of MITEI’s research portfolio reflects its core mission of enabling the low-carbon economy of the future through the adoption of renewable energy, energy efficiency, and carbon management technologies. The largest single area of funded research is solar energy technology and policy. Much of the remainder of the portfolio is concerned with meeting contemporary energy needs through the efficient use of conventional energy sources.

This year, MITEI funded nine undergraduate energy curriculum projects through a grant from the S.D. Bechtel, Jr. Foundation. It has awarded nearly 350 graduate fellowships in energy and supported well over 200 Undergraduate Research Opportunities Program (UROP) students since 2008. In 2015, with the graduation of 19 Energy Studies Minor students, the Minor achieved a milestone: 108 students have graduated since the Minor began in 2009. Faculty associated with MITEI help shape energy education at both the undergraduate and graduate levels, by teaching, advising, and developing new curricula.

MITEI’s outreach program promotes and disseminates energy research findings to the MIT community, as well as to policy makers, industry leaders, and other stakeholders. Through colloquia, symposia, and seminars, MITEI introduces energy thought leaders from across the energy value chain to the local audience, which includes the MIT community, students and faculty at nearby colleges and universities, as well as Boston and Cambridge area politicians, energy industry personnel, and interested residents.

http://mitei.mit.edu/
Section 3
Students

Undergraduate Students  49
Graduate Students  50
Degrees  51
Alumni  52
Undergraduate Financial Aid  53
Graduate Financial Aid  56
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 114-116 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
Students

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 undergraduates 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>

*Excludes non-matriculating students

Graduate Students by Gender, 2014–2015

<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2,719</td>
<td>2,719</td>
</tr>
</tbody>
</table>

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**

In 2014–2015, MIT awarded 3,439 degrees.

### Degrees Awarded by Type, 2014–2015

<table>
<thead>
<tr>
<th>Degree Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science degrees</td>
<td>1,099</td>
</tr>
<tr>
<td>Master of Science degrees</td>
<td>685</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>1,034</td>
</tr>
<tr>
<td>Engineer’s degrees</td>
<td>15</td>
</tr>
<tr>
<td>Doctoral degrees</td>
<td>606</td>
</tr>
</tbody>
</table>

### Degrees Awarded by School, 2014–2015

<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>9</td>
<td>184</td>
<td>36</td>
<td>229</td>
</tr>
<tr>
<td>Engineering</td>
<td>764</td>
<td>713</td>
<td>348</td>
<td>1,825</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>49</td>
<td>24</td>
<td>29</td>
<td>102</td>
</tr>
<tr>
<td>Management</td>
<td>18</td>
<td>790</td>
<td>26</td>
<td>834</td>
</tr>
<tr>
<td>Science</td>
<td>259</td>
<td>23</td>
<td>167</td>
<td>449</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,099</strong></td>
<td><strong>1,734</strong></td>
<td><strong>606</strong></td>
<td><strong>3,439</strong></td>
</tr>
</tbody>
</table>

### Degrees Awarded by Gender, 2014–2015

<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>486</td>
<td>441</td>
<td>927</td>
</tr>
<tr>
<td>Master’s and Engineer’s</td>
<td>613</td>
<td>586</td>
<td>1199</td>
</tr>
<tr>
<td>Doctorate</td>
<td>165</td>
<td></td>
<td>165</td>
</tr>
</tbody>
</table>

**Number of Degrees Awarded**

- **Architecture and Planning**: Bachelor’s - 200, Master’s and Engineer’s - 800, Doctorate - 100
- **Engineering**: Bachelor’s - 500, Master’s and Engineer’s - 1200, Doctorate - 250
- **Humanities, Arts, and Social Sciences**: Bachelor’s - 50, Master’s and Engineer’s - 900, Doctorate - 150
- **Management**: Bachelor’s - 150, Master’s and Engineer’s - 900, Doctorate - 100
- **Science**: Bachelor’s - 50, Master’s and Engineer’s - 800, Doctorate - 100
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 132,373 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 14,000 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.
- Need-based financial aid: MIT awards aid only for financial need. It does not award undergraduate scholarships for academic or athletic achievements or for other non-financial criteria.
- 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 2014–2015, the annual price of an MIT education totaled $61,530 per student—$45,016 for tuition and fees, $13,224 for room and board, an estimated $2,790 for books, supplies, and personal expenses, and a per-student average of $500 for travel. With 4,476 undergraduates enrolled, the collective price for undergraduates was $275.4 million. Of this amount, families paid $146.1 million, or 53 percent, and financial aid covered the remaining 47 percent, or $129.3 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 85.8 percent while the share in the form of student loans fell from 11.1 to 6.7 percent and term-time work decreased from 8.0 to 7.4 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 other higher education institutions.

<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>111,003,808</td>
<td>86</td>
</tr>
<tr>
<td>Student Loans</td>
<td>8,710,328</td>
<td>7</td>
</tr>
<tr>
<td>Term-time employment</td>
<td>9,623,864</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>129,338,000</td>
<td>100</td>
</tr>
</tbody>
</table>
Sources of Undergraduate Financial Aid

In 2014–2015, MIT provided 77.1 percent of undergraduate financial aid. The federal government provided 11.7 percent, and the remaining 11.2 percent came from state and private resources. MIT 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 scholarship, averaging $36,726 each. These scholarships 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. Two states, in addition to Massachusetts, allow their residents to receive a state grant while attending MIT: Pennsylvania and Vermont. Most state grants are need-based.

<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>99,710,485</td>
<td>77</td>
</tr>
<tr>
<td>Federal Financial Aid</td>
<td>15,154,350</td>
<td>12</td>
</tr>
<tr>
<td>State Financial Aid</td>
<td>174,078</td>
<td>0</td>
</tr>
<tr>
<td>Private Financial Aid</td>
<td>14,299,087</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>129,338,000</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The following table summarizes the sources and types of financial aid MIT undergraduates received in 2014–2015.

<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>91,852,488</td>
<td>2501</td>
<td>290,000</td>
<td>89</td>
</tr>
<tr>
<td>Federal</td>
<td>7,289,187</td>
<td>842</td>
<td>5,809,296</td>
<td>823</td>
</tr>
<tr>
<td>State</td>
<td>174,078</td>
<td>91</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Private</td>
<td>11,688,055</td>
<td>1327</td>
<td>2,611,032</td>
<td>118</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>111,003,808</strong></td>
<td><strong>3138</strong></td>
<td><strong>8,710,328</strong></td>
<td><strong>946</strong></td>
</tr>
</tbody>
</table>

*The total column and row are unduplicated numbers of students.
**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 ($44,720 for the 2014–2015 academic year). Another portion ($2,268) 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 $33,252 for a doctoral student). MIT houses approximately 36% 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.

---

**Graduate Student Financial Support, 2014–2015**

- Tuition, $44,720
- Typical 12-month Science and Engineering Doctoral Stipend, $33,252
- Health Insurance, $2,268

**Doctoral Graduate Student Support, 2014–2015**

- Graduate Research Assistantships (RA)
- Graduate Teaching Assistantships (TA)
- Graduate fellowships
- Other types of support, including no support

Percent of Doctoral Students

0% 10% 20% 30% 40% 50% 60%
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 2014, the breakdown of funding sources for students that were primarily supported by fellowships were 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>22</td>
</tr>
<tr>
<td>National Institutes of Health</td>
<td>32</td>
</tr>
<tr>
<td>NASA</td>
<td>24</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>199</td>
</tr>
<tr>
<td>Other Federal Agencies</td>
<td>1</td>
</tr>
<tr>
<td>Other U.S. sources</td>
<td>43</td>
</tr>
<tr>
<td>Non-U.S. sources</td>
<td>100</td>
</tr>
<tr>
<td>MIT Internal</td>
<td>1,303</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,813</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.

Appointments to teaching assistantships are made upon recommendation of the head of a department. Only full-time graduate students who are candidates for advanced degrees may be appointed, and the Free Application for Federal Student Aid (FAFSA) is required for all teaching assistants who are U.S. citizens or permanent residents.

**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 $0.9 million in 2014–2015, with 0.78 percent of graduate and professional students (52 students) earning $17,458 on average.

In AY2015, graduate students borrowed loans that totaled $43.3 million, a decrease of approximately $1.6 million from the prior year, with 11.2 percent of graduate and professional students (741 students) borrowing an average of $58,471.
Section 4
Campus Research

Research Support 60
Campus Research Sponsors 62
  Department of Defense 64
  Department of Energy 66
  National Institutes of Health 68
  NASA 70
  National Science Foundation 72
  Other Federal Agencies 74
  Nonprofit Organizations 76
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 FY2015)

<table>
<thead>
<tr>
<th>Location</th>
<th>Expenditures (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambridge Campus</td>
<td>$696.9</td>
</tr>
<tr>
<td>Lincoln Laboratory*</td>
<td>$890.2</td>
</tr>
<tr>
<td>SMART*</td>
<td>$31.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,619.0</strong></td>
</tr>
</tbody>
</table>

*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 FY2015, there were 2,723 active awards and 396 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.

MIT Research Expenditures

1940–2015

†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 2015 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.

Campus Research

**Campus Research Expenditures and Faculty Excluding Broad and Defense Labs 1940–2015**

Fiscal Year

<table>
<thead>
<tr>
<th>Research Expenditures in Millions</th>
<th>Number of Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>0</td>
</tr>
<tr>
<td>$100</td>
<td>100</td>
</tr>
<tr>
<td>$200</td>
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<tr>
<td>$1,300</td>
<td>1,300</td>
</tr>
<tr>
<td>$1,400</td>
<td>1,400</td>
</tr>
</tbody>
</table>

**Campus Federal**

**Campus Non-Federal**

**Constant $**

**Faculty excluding DAPER & DSL**

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 79. Expenditures funded by industrial sponsors are shown on page 99 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 2006–2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>382,784,774</td>
<td>114,361,780</td>
<td>497,146,554</td>
</tr>
<tr>
<td>2007</td>
<td>373,603,371</td>
<td>114,389,201</td>
<td>487,992,571</td>
</tr>
<tr>
<td>2008</td>
<td>369,008,780</td>
<td>132,487,316</td>
<td>501,496,096</td>
</tr>
<tr>
<td>2009</td>
<td>381,459,466</td>
<td>158,595,887</td>
<td>540,055,353</td>
</tr>
<tr>
<td>2010</td>
<td>430,154,479</td>
<td>184,216,417</td>
<td>614,370,896</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>469,520,579</td>
<td>191,304,692</td>
<td>660,825,271</td>
</tr>
<tr>
<td>2012</td>
<td>472,582,743</td>
<td>208,496,567</td>
<td>681,079,310</td>
</tr>
<tr>
<td>2013</td>
<td>465,946,679</td>
<td>208,401,668</td>
<td>674,348,348</td>
</tr>
<tr>
<td>2014</td>
<td>454,938,599</td>
<td>223,473,071</td>
<td>678,411,670</td>
</tr>
<tr>
<td>2015</td>
<td>459,979,141</td>
<td>236,912,028</td>
<td>696,891,169</td>
</tr>
</tbody>
</table>

#### Research Expenditures in Millions

- **MIT Internal**
- **State, Local, and Foreign Governments**
- **Foundations and other Nonprofits**
- **Industry**
- **All Other Federal**
- **National Science Foundation**
- **NASA**
- **National Institutes of Health†**
- **Department of Energy**
- **Department of Defense**
- **Constant Dollars**

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 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>FY2015 (In U.S. Dollars)</th>
<th>Percent of Campus Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Defense</td>
<td>125,853,521</td>
<td>18</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>81,528,299</td>
<td>12</td>
</tr>
<tr>
<td>National Institutes of Health*</td>
<td>116,469,457</td>
<td>17</td>
</tr>
<tr>
<td>NASA</td>
<td>41,739,692</td>
<td>6</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>78,952,919</td>
<td>11</td>
</tr>
<tr>
<td>All other federal</td>
<td>15,435,252</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Federal</strong></td>
<td><strong>459,979,141</strong></td>
<td><strong>66</strong></td>
</tr>
<tr>
<td>Industry</td>
<td>119,238,077</td>
<td>17</td>
</tr>
<tr>
<td>Foundations and other nonprofit</td>
<td>78,666,639</td>
<td>11</td>
</tr>
<tr>
<td>State, local, and foreign governments</td>
<td>27,951,041</td>
<td>4</td>
</tr>
<tr>
<td>MIT internal</td>
<td>11,056,271</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Non-Federal</strong></td>
<td><strong>236,912,028</strong></td>
<td><strong>34</strong></td>
</tr>
<tr>
<td>Campus Total</td>
<td><strong>696,891,169</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*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.
Department of Defense

Selected Projects

A bipedal robot with human reflexes
On the MIT campus, a two-legged robot named HERMES is wreaking controlled havoc: punching through drywall, and kicking over trash buckets. Its actions, however, are not its own. Just a few feet away, PhD student Joao Ramos stands on a platform, wearing an exoskeleton of wires and motors. Ramos’ every move is translated instantly to HERMES, much like a puppeteer controlling his marionette. As Ramos mimes punching through a wall, the robot does the same. When the robot’s fist hits the wall, Ramos feels a jolt at his waist. By reflex, he leans back against the jolt, causing the robot to rock back, effectively balancing the robot against the force of its punch.

The exercises are meant to demonstrate the robot’s unique balance-feedback interface. Without this interface, while the robot may successfully punch through a wall, it would also fall headlong into that wall. The interface allows a human to remotely feel the robot’s shifting weight, and quickly adjust the robot’s balance by shifting his own weight. As a result, the robot can carry out momentum-driven tasks—like punching through walls—while maintaining its balance.

Ramos and his colleagues, including PhD student Albert Wang and Professor Sangbae Kim, will present a paper on the interface at the IEEE/RSJ International Conference on Intelligent Robots and Systems.

A new look at superfluidity
MIT physicists have created a superfluid gas, the so-called Bose-Einstein condensate, for the first time in an extremely high magnetic field. The magnetic field is a synthetic magnetic field, generated using laser beams, and is 100 times stronger than that of the world’s strongest magnets. Within this magnetic field, the researchers could keep a gas superfluid for a tenth of a second—just long enough for the team to observe it. The team, led by Wolfgang Ketterle, took pictures of the distribution of atoms to capture the shape of the superfluid. Those images also reveal the structure of the magnetic field—something that’s been known, but never directly visualized until now.

A superfluid is a phase of matter that only certain liquids or gases can assume, if they are cooled to extremely low temperatures. Superfluids are thought to flow endlessly, without losing energy, similar to electrons in a superconductor. Observing the behavior of superfluids may help scientists improve the quality of superconducting magnets and sensors, and develop energy-efficient methods for transporting electricity.

Solving mysteries of conductivity in polymers
Materials known as conjugated polymers have been seen as very promising candidates for electronics applications, including photodiodes, and thermoelectric devices. But they’ve faced one major obstacle: Nobody has been able to explain just how electrical conduction worked in these materials, or to predict how they would behave when used in such devices.

Conjugated polymers fall somewhere between crystalline and amorphous materials—and that’s caused some of the difficulty in explaining how they work, says Asli Ugur, an MIT postdoc and research team member. Crystals have a perfectly regular arrangement of atoms and molecules, while amorphous materials have a completely random arrangement. Conjugate polymers have characteristics of both. Researchers at MIT and Brookhaven National Laboratory have explained how electrical charge carriers move in these compounds, potentially opening up further research on such applications.

The research team also included Professor Karen Gleason, Associate Professor Kripa Varanasi, postdoc Ferhat Katmis and graduate student Mingda Li, and Brookhaven National Laboratory research scientists Lijun Wu and Yimei Zhu.

http://newsoffice.mit.edu/2015/solving-mysteries-conductivity-polymers-0714
Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2015
(Shown in descending order of expenditures)

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

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.

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.
A small, modular, efficient fusion plant
Advances in magnet technology have enabled researchers to propose a new design for a practical compact tokamak fusion reactor—that might be realized in as little as a decade, they say. The era of practical fusion power, which could offer a nearly inexhaustible energy resource, may be coming near.

Using these new commercially available superconductors, rare-earth barium copper oxide (REBCO) superconducting tapes, to produce high-magnetic field coils “just ripples through the whole design,” says Dennis Whyte, a professor of Nuclear Science and Engineering and director of MIT’s Plasma Science and Fusion Center. “It changes the whole thing.”

The stronger magnetic field makes it possible to produce the required magnetic confinement of the superhot plasma—that is, the working material of a fusion reaction—but in a much smaller device than those previously envisioned. The reduction in size makes the whole system less expensive and faster to build, and also allows for some ingenious new features in the power plant design. The proposed reactor, using a tokamak (donut-shaped) geometry that is widely studied, is described in a paper in the journal Fusion Engineering and Design, co-authored by Whyte, PhD candidate Brandon Sorbom, and 11 others at MIT. The paper started as a design class taught by Whyte and became a student-led project after the class ended.

MIT awarded Dept. of Energy grant to create and deploy energy-saving travel information and incentives system
The U.S. Department of Energy’s Advanced Research Projects Agency-Energy (ARPA-E) has announced that MIT researchers, along with colleagues from the University of Massachusetts (UMass), received a $3,990,128 grant to design, build, and trial a new system to incentivize people to adapt their travel choices to conserve energy.

Professor Moshe Ben-Akiva and Assistant Professor Jessika Trancik will lead the project, involving a diverse team from several MIT departments. The MIT team will work with UMass Associate Professor Song Gao and colleagues. The innovative initiative is one of five proposals funded as part of ARPA-E’s newest program, the Traveler Response Architecture using Novel Signaling for Network Efficiency in Transportation (TRANSNET).

The grant will be used to develop and test a Mobility Electronic Market for Optimized Travel (MeMOT). It will use real and simulated personal travel data to reward people to shift their routes, departure times, modes of travel, and vehicles based on live information they receive from MeMOT. Incentives will include points awarded based on energy savings that can be redeemed both in real-time and in the future for travel-related and other benefits at local participating vendors.

New manufacturing approach slices lithium-ion battery cost in half
An advanced manufacturing approach for lithium-ion batteries, developed by researchers at MIT and at a spinoff company called 24M, promises to significantly slash the cost of the most widely used type of rechargeable batteries while also improving their performance and making them easier to recycle.

“We’ve reinvented the process,” says Yet-Ming Chiang, professor and a co-founder of 24M. The existing process for manufacturing lithium-ion batteries, he says, has hardly changed in the two decades since the technology was invented, and is inefficient, with more steps and components than are really needed.

The new process is based on a concept developed five years ago by Chiang and colleagues including Professor W. Craig Carter. The new battery design is a hybrid between flow batteries and conventional solid ones: In this version, while the electrode material does not flow, it is composed of a similar semisolid, colloidal suspension of particles. Chiang and Carter refer to this as a “semisolid battery.”
Leading Departments, Laboratories, and Centers
Receiving Support in Fiscal Year 2015
(Shown in descending order of expenditures)

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

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

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

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.
National Institutes of Health
Selected Projects

Uncovering a dynamic cortex
Researchers at MIT have proven that the brain’s cortex doesn’t process specific tasks in highly specialized modules—showing that the cortex is, in fact, quite dynamic when sharing information.

Previous studies of the brain have depicted the cortex as a patchwork of function-specific regions. In a paper published in *Science*, researchers from the Picower Institute for Learning and Memory at MIT show that, indeed, multiple cortical regions work together simultaneously to process sensorimotor information—sensory input coupled with related actions—despite their predetermined specialized roles.

The researchers used cutting-edge techniques to record neural activity simultaneously, for the first time, across six cortical regions during a task in which the color or motion of dots had to be identified. These regions, ranging from the front to back of the brain, were thought to each specialize in specific sensory or executive functions. Yet the researchers found significant encoding for all information across all regions—but at varying degrees of strength and timing.

These findings, Professor Earl Miller says, could lead to improved treatments for brain disease, attention deficit hyperactivity disorder, stroke, and trauma.

The paper’s lead author is Markus Siegel, a principal investigator at the University of Tübingen, and a co-author is Timothy Buschman, an assistant professor at Princeton University. Miller is senior author.

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 tissue glue works through a system where molecules in the adhesive interact with chemical structures found in abundance in structural tissue known as collagen. When enough of the molecules and collagen bind to each other, the adhesive forms a tight seal. This system is disrupted in colitic tissue because the inflammation breaks down collagen. However, cancerous tissue tends to have excess collagen.

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

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 healthcare 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.

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 Elena de Puig, postdoc Justina Tam, instructor Jose Gomez-Marquez, and visiting scientist Irene Bosch.

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

http://news.mit.edu/2015/tailored-tissue-adhesives-0128

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2015
(Shown in descending order of expenditures)

Koch Institute for Integrative Cancer Research
Biological Engineering
Picower Institute for Learning and Memory
Chemistry
McGovern Institute for Brain Research
Computer Science and Artificial Intelligence Laboratory
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.

Ten 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, Mehmet Yanik, and Feng Zhang.

National Institutes of Health Campus Research Expenditures (in U.S. Dollars)*
Fiscal Years 2011–2015

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>$152,664,013</td>
<td>$133,687,332</td>
<td>$119,908,451</td>
<td>$115,074,564</td>
<td>$116,469,457</td>
</tr>
<tr>
<td>Constant dollars†</td>
<td>$163,428,625</td>
<td>$139,040,157</td>
<td>$122,667,889</td>
<td>$115,912,281</td>
<td>$116,469,457</td>
</tr>
</tbody>
</table>

*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.
† Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.
Working out in artificial gravity
Astronauts on the International Space Station (ISS) have a number of exercise options, including a mechanical bicycle bolted to the floor, a weightlifting machine strapped to the wall, and a strap-down treadmill. They spend a significant portion of each day working out to ward off the long-term effects of weightlessness, but many still suffer bone loss, muscle atrophy, and issues with balance and their cardiovascular systems.

To counteract such debilitating effects, research groups around the world are investigating artificial gravity—the notion that astronauts, exposed to strong centrifugal forces, may experience the effects of gravity, even in space. Engineers have been building and testing human centrifuges—spinning platforms that, at high speeds, generate G-forces strong enough to mimic gravity.

Now engineers at MIT have built a compact human centrifuge with an exercise component: a cycle ergometer that a person can pedal as the centrifuge spins. The centrifuge was sized to just fit inside a module of the ISS. After testing the setup on healthy participants, the team found the combination of exercise and artificial gravity could significantly lessen the effects of extended weightlessness in space—more so than exercise alone.

Professor Laurence Young says artificial gravity would be a huge benefit for astronauts, particularly those embarking on long-duration space missions, such as a journey to Mars. The risks, he says, are uncertain, but potentially significant. He and his colleagues, former graduate students Ana Diaz and Chris Trigg, have published results from their experiments in the journal Acta Astronautica.

http://newsoffice.mit.edu/2015/exercise-artificial-gravity-space-0702

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.


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

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http://newsoffice.mit.edu/2015/meteorites-byproducts-of-planetary-formation-0114
NASA Campus Research Expenditures (in U.S. Dollars)
Fiscal Years 2011–2015

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>28,079,693</td>
<td>30,203,575</td>
<td>29,834,713</td>
<td>32,062,601</td>
<td>41,739,692</td>
</tr>
<tr>
<td>Constant dollars*</td>
<td>30,059,642</td>
<td>31,412,923</td>
<td>30,521,295</td>
<td>32,296,010</td>
<td>41,739,692</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.

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

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2015
(Shown in descending order of expenditures)

- Kavli Institute for Astrophysics and Space Research
- Earth, Atmospheric and Planetary Sciences
- Aeronautics and Astronautics
- Haystack Observatory
- Center for Global Change Science
- Media Laboratory
- Civil and Environmental Engineering
- Research Laboratory of Electronics
- Laboratory for Manufacturing and Productivity
- Microsystems Technology Laboratories
Unusual magnetic behavior observed at a material interface

An exotic kind of magnetic behavior, driven by the mere proximity of two materials, has been analyzed by a team of researchers using a technique called spin-polarized neutron reflectometry. They say the new finding could be used to probe a variety of exotic physical phenomena, and could ultimately be used to produce key components of future quantum computers.

The phenomenon occurs at the boundary between a ferromagnet and a topological insulator, which blocks electricity from flowing through all of its bulk but whose surface is, by contrast, a very good electrical conductor. In the new work, a layer of topological insulator material is bonded to a ferromagnetic layer. Where the two materials meet, an effect takes place called proximity-driven magnetic order, producing a localized and controllable magnetic pattern at the interface.

One of the new findings of this research is that the magnetism induced by the proximity of the two materials is not just at the surface, but actually extends into the interior of the topological insulator material. Possible applications of the new findings include the creation of spintronics, transistors based on the spin of particles rather than their charge. These are expected to have low energy dissipation if based on topological insulators, and are a very active area of research.

The research is described in a paper in the journal *Physical Review Letters*, written by doctoral student Mingda Li, postdoc Cui-Zu Chang, professor Ju Li, senior scientist Jagadeesh Moodera, and seven others. The work included researchers at the National Institute of Standards and Technology, Brookhaven National Laboratory, Northeastern University, and Boston College.

**Predicting the shape of river deltas**

The Mississippi River delta is a rich ecosystem of barrier islands, estuaries, and wetlands that's home to a diverse mix of wildlife—as well as more than 2 million people. Over the past few decades, the shape of the delta has changed significantly, as ocean waves have carved away at the coastline, and marshes lacking new river sediment have submerged habitats.

To keep flooding at bay, engineers have erected dams and levees along the river. However, it's unclear how such measures will affect the shape of the delta, and affect its communities, over time. Now researchers from MIT and the Woods Hole Oceanographic Institution (WHOI) have devised a simple way to predict a river delta's shape, given two competing factors: how fast a river forces sediment into the ocean, and ocean waves' strength in pushing that sediment back along the coast. The new metric may help engineers determine how the shape of deltas around the world may shift in response to engineered structures such as dams and levees, and environmental changes, such as hurricane activity and sea-level rise.

Jaap Nienhuis, a graduate student in the MIT-WHOI Joint Program in Marine Geology and Geophysics, and Andrew Ashton and Liviu Giosan of WHOI, report their results in the journal *Geology*.

Giving robots a more nimble grasp

Engineers at MIT have now hit upon a way to impart more dexterity to simple robotic grippers: using the environment as a helping hand. The team, led by assistant professor Alberto Rodriguez, and graduate student Nikhil Chavan-Dafle, has developed a model that predicts the force with which a robotic gripper needs to push against various fixtures in the environment in order to adjust its grasp on an object. For instance, if a robotic gripper aims to pick up a pencil at its midpoint, but instead grabs hold of the eraser end, Rodriguez's model enables a robot to loosen its grip slightly, and push the pencil against a nearby wall, just enough to slide the robot's gripper closer to the pencil's midpoint.

With Rodriguez's new approach, robots in manufacturing, disaster response, and other gripper-based applications may interact with the environment, in a cost-effective way, to perform more complex maneuvers.
Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2015
(Shown in descending order of expenditures)

Computer Science and Artificial Intelligence Laboratory
Research Laboratory of Electronics
Earth, Atmospheric and Planetary Sciences
Biological Engineering
McGovern Institute for Brain Research
Kavli Institute for Astrophysics and Space Research
Haystack Observatory
Mathematics
Chemistry
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 155 current faculty and staff members.
Other Federal Agencies
Selected Projects

Can rain clean the atmosphere?
As a raindrop falls through the atmosphere, it can attract tens to hundreds of tiny aerosol particles to its surface before hitting the ground. The process by which droplets and aerosols attract is coagulation, a natural phenomenon that can act to clear the air of pollutants like soot and organic particles.

Atmospheric chemists at MIT have now determined just how effective rain is in cleaning the atmosphere. Given the altitude of a cloud, the size of its droplets, and the diameter and concentration of aerosols, the team can predict the likelihood that a raindrop will sweep a particle out of the atmosphere.

The researchers carried out experiments in the group’s MIT Collection Efficiency Chamber—a 3-foot-tall glass chamber that generates single droplets of rain at a controlled rate and size. As droplets fell through the chamber, researchers pumped in aerosol particles, and measured the rate at which droplets and aerosols merged, or coagulated. In general, they found that the smaller the droplet, the more likely it was to attract a particle. Conditions of low relative humidity also seemed to encourage coagulation.

Dan Cziczo, an associate professor, says the new results, published in the journal Atmospheric Chemistry and Physics, represent the most accurate values of coagulation to date. These values, he says, may be extrapolated to predict rain’s potential to clear a range of particles in various environmental conditions.

The paper’s co-authors are postdoc Karin Ardon-Dryer and former postdoc Yi-Wen Huang. This research was funded, in part, by the National Oceanic and Atmospheric Administration.

Measuring climate change action
Reducing global greenhouse gas emissions could have big benefits in the U.S., according to a report released by the U.S. Environmental Protection Agency (EPA), including thousands of avoided deaths from extreme heat, billions of dollars in saved infrastructure expenses, and prevented destruction of natural resources and ecosystems.

The report, “Climate Change in the United States: Benefits of Global Action”, relies on research developed at the MIT Joint Program on the Science and Policy of Global Change to estimate the effects of climate change on 22 sectors in six areas: health, infrastructure, electricity, water resources, agriculture and forestry, and ecosystems.

The MIT researchers developed two suites of future climate scenarios, socioeconomic scenarios, and technological assumptions that serve as the foundation of the EPA report’s findings. In the first scenario, no new constraints were placed on greenhouse gas emissions. In the second, global warming was limited to 2 degrees Celsius through global climate action.

Research groups across the country then built on the scenarios developed at MIT to study how different sectors in the U.S. would fare under each future scenarios. The groups studied a diverse range of impacts of climate change according to their own areas of expertise, ranging from lost wages due to extreme temperatures, to damage to bridges from heavy river flows, among others. The MIT team also contributed heavily to the section of the report focusing on water resources. The report concludes that mitigating greenhouse gas emissions can reduce the risk of both damaging floods and droughts, and prevent future water management issues.

The report is part of the ongoing Climate Impacts and Risk Analysis (CIRA) program, an EPA-led collaborative modeling effort among teams in the federal government, MIT, the Pacific Northwest National Laboratory, the National Renewable Energy Laboratory, and several consulting firms. The report summarizes more than 35 studies that were individually peer reviewed in scientific journals.

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 2015

(Shown in descending order of expenditures)

- Center for Transportation and Logistics
- Aeronautics and Astronautics
- Computer Science and Artificial Intelligence Laboratory
- Sea Grant College Program
- Civil and Environmental Engineering
- Urban Studies and Planning
- Mechanical Engineering
- Center for Global Change Science
- Materials Processing Center
- Sociotechnical Systems Research Center

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)

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>16,602,212</td>
<td>18,806,804</td>
<td>19,993,508</td>
<td>17,611,014</td>
<td>15,435,252</td>
</tr>
<tr>
<td>Constant dollars*</td>
<td>17,772,863</td>
<td>19,559,826</td>
<td>20,453,616</td>
<td>17,739,219</td>
<td>15,435,252</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.
Ocean acidification may cause dramatic changes to phytoplankton

Oceans have absorbed up to 30 percent of human-made carbon dioxide around the world, storing dissolved carbon for hundreds of years. Since pre-industrial times, the pH of the oceans has dropped from an average of 8.2 to 8.1 today. Projections of climate change estimate that by the year 2100, this number will drop further, to around 7.8—significantly lower than any levels seen in open ocean marine communities today.

A team of researchers from MIT, the University of Alabama at Birmingham, and elsewhere has found that such increased ocean acidification will dramatically affect global populations of phytoplankton—microorganisms on the ocean surface that make up the base of the marine food chain.

In a study published in the journal Nature Climate Change, the researchers report that increased ocean acidification by 2100 will spur a range of responses in phytoplankton: Some species will die out, while others will flourish, changing the balance of plankton species around the world.

The researchers also compared phytoplankton’s response to other projected drivers of climate change, such as warming temperatures and lower nutrient supplies. Based on global simulations, however, they found the most dramatic effects stemmed from ocean acidification.

Stephanie Dutkiewicz, a principal research scientist in MIT’s Center for Global Change Science, says that while scientists have suspected ocean acidification might affect marine populations, the group’s results suggest a much larger upheaval of phytoplankton—microorganisms on the ocean surface that make up the base of the marine food chain.

Nonprofit Organizations

Selected Projects

New material opens possibilities for super-long-acting pills

Medical devices designed to reside in the stomach have a variety of applications, including prolonged drug delivery, electronic monitoring, and weight-loss intervention. However, these devices, often created with nondegradable elastic polymers, bear an inherent risk of intestinal obstruction as a result of accidental fracture or migration. As such, they are usually designed to remain in the stomach for a limited time.

Researchers at MIT’s Koch Institute for Integrative Cancer Research and Massachusetts General Hospital (MGH) have created a polymer gel that overcomes this safety concern and could allow for the development of long-acting devices that reside in the stomach, that can release drugs over a number of days, weeks, or potentially months following a single administration. This polymer is pH-responsive: It is stable in the acidic stomach environment but dissolves in the small intestine’s near-neutral pH, allowing for safe passage through the remainder of the gastrointestinal (GI) tract. The material is also elastic, allowing for the compression and folding of devices into easily ingestible capsules—meaning this polymer can be used to create safe devices designed for extremely prolonged residence in the stomach.

Koch Institute research affiliate Giovanni Traverso, also a gastroenterologist at MGH and an instructor at Harvard Medical School, and Robert Langer, the David H. Koch Institute Professor at MIT and a member of the Koch Institute, are the senior authors of a paper in Nature Materials that describes the application of this new polymer gel for creating gastric devices. Shiyi Zhang, a postdoc at the Koch Institute, is the paper’s lead author. The paper’s other authors include Andrew Bellinger, Dean Glettig, Ross Barman, Young-Ah Lee, Cody Cleveland, Veronica Montgomery, and Li Gu from MIT; Jiahua Zhu from Oak Ridge National Laboratory; and Landon Nash and Duncan Maitland from Texas A&M University.

Nonprofit Organizations Campus Research Expenditures (in U.S. Dollars)
Fiscal Years 2011–2015

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>44,436,470</td>
<td>48,373,460</td>
<td>58,226,616</td>
<td>72,117,488</td>
<td>78,666,639</td>
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<tr>
<td>Constant dollars*</td>
<td>47,569,765</td>
<td>50,310,328</td>
<td>59,566,578</td>
<td>72,642,488</td>
<td>78,666,639</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.

Leading Departments, Laboratories, and Centers
Receiving Support in Fiscal Year 2015
(Shown in descending order of expenditures)

Koch Institute for Integrative Cancer Research
Masdar
Computer Science and Artificial Intelligence Laboratory
Economics
Civil and Environmental Engineering
Research Laboratory of Electronics
Mechanical Engineering
McGovern Institute for Brain Research
Biological Engineering
Materials Processing Center
Section 5
Lincoln Laboratory

Research Expenditures 81
Authorized Funding 81
Lincoln Laboratory’s Economic Impact 82
Air and Missile Defense Technology 83
Communication Systems 84
Cyber Security and Information Sciences 85
Intelligence, Surveillance, and Reconnaissance Systems and Technology 86
Tactical Systems 86
Space Control 87
Advanced Technology 88
Homeland Protection 89
Aviation Research 90
Advanced Research Portfolio 91
Lincoln Laboratory Staffing 92
Test Facilities and Field Sites 93
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 Expenditures by Type Fiscal Year 2014*

<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>

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

### Top Seven States Amount

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts†</td>
<td>185.3</td>
</tr>
<tr>
<td>California</td>
<td>30.1</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>28.1</td>
</tr>
<tr>
<td>Texas</td>
<td>23.0</td>
</tr>
<tr>
<td>Kentucky</td>
<td>12.1</td>
</tr>
<tr>
<td>New Jersey</td>
<td>11.8</td>
</tr>
<tr>
<td>Colorado</td>
<td>11.3</td>
</tr>
</tbody>
</table>

†Does not include orders to MIT ($21.1 million)

### Goods and Services Expenditures by State Fiscal Year 2014*

*Massachusetts† 51%

### Other New England States Amount

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>5.7</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>1.2</td>
</tr>
<tr>
<td>Vermont</td>
<td>0.3</td>
</tr>
<tr>
<td>Maine</td>
<td>0.1</td>
</tr>
</tbody>
</table>

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Air and Missile Defense Technology
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.

Air and Missile Defense Technology
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.
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.

Communication Systems
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.
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.

Cyber Security and Information Sciences
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.
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.
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.

Space Control
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.
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.
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.

Aviation Research
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.
Advanced Research Portfolio

Internal research and development at MIT Lincoln Laboratory is supported through a Congressionally appropriated source of funding, known as the Line, that is administered by the office of the Assistant Secretary of Defense for Research and Engineering (ASD[R&E]). The Line is the Laboratory’s primary source of relatively unconstrained funding and is used to fund the long-term strategic technology capabilities of established and emerging mission areas. Line projects form an Advanced Research portfolio that focuses on addressing technology gaps in critical problems facing national security. Successful projects often result in advanced capabilities that lead to further sponsored program development.

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 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.*
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.

Professional Technical Staff Profile

Degrees Held by Lincoln Laboratory Professional Technical Staff

- Doctorate: 42%
- Master’s: 35%
- Bachelor’s: 20%
- No Degree: 3%

Academic Disciplines of Lincoln Laboratory Professional Technical Staff

- Electrical Engineering: 35%
- Computer Science, Computer Engineering, Computer Information Systems: 16%
- Mathematics: 7%
- Physics: 16%
- Biology, Chemistry, Meteorology, Materials Science: 10%
- Aerospace/Astronautics: 5%
- Mechanical Engineering: 7%
- Other: 4%
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 6
MIT and Industry

Partnering at MIT 96
Selected Projects 98
Campus Research Sponsored by Industry 99
Managing the Industry/University Interface 100
Entrepreneurship 100
Learning 102
Recruiting 103
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.

- Industry sponsored R&D at MIT totaled $128 million in FY2014.

- Over 750 companies provided R&D/gift support to MIT; 36 companies funded $1 million+, 193 companies funded $100 thousand–$1 million.

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:

- 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.

**ExxonMobil**

In 2014, ExxonMobil became a founding member of the MIT Energy Initiative (MITEI), a unique collaboration aimed at working together to advance and explore the future of energy. ExxonMobil has had a long and productive relationship with faculty and students at MIT, and in its most recent agreement collaborates on a wide range of projects, including research to improve and expand renewable energy sources and find more efficient ways to produce and use conventional hydrocarbon resources. The agreement also establishes 10 graduate energy fellowship appointments each year at MIT (ExxonMobil Energy Fellows). These fellowships will support operating costs and expenses for talented graduate students while they pursue their selected areas of study and research.

**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.

**Philips**

In May 2015, Philips announced an alliance with MIT that will ultimately support MIT research in the company’s core areas of health care and lighting solutions technology. The agreement follows the company’s recent decision to move its North American research headquarters to Kendall Square, citing the area’s concentration of startups and research labs—especially in the biomedical area—and for its proximity to MIT. Research projects under the alliance are expected to focus on areas such as lighting for green buildings and cities; clinical decision support; clinical informatics; interventional guidance, planning, and assessment; and medical ultrasound, photonics, and bioinformatics.

**RIKEN**

RIKEN is a nonprofit corporation with financial support furnished by the Japanese government and industry. It has funded research at MIT in learning and memory, neuroscience of higher order cognition, and plasticity of the developing and mature brain. Since its 1998 “Agreement for Collaboration in Neuroscience Research, the fruitful RIKEN collaboration has created the RIKEN-MIT Neuroscience Research Center, the RIKEN Brain Science Institute (BSI), and the RIKEN-MIT Center for Neural Circuit Genetics, directed by Nobel Laureate Susumu Tonegawa.

**Samsung**

Samsung chose MIT for its energy research focus and the decision to embark on this collaboration was made in parallel with the establishment of its Advanced Materials Lab in Cambridge. Current project topics include energy storage, all-inorganic quantum dot photovoltaics, computational materials design (materials genome), and functional layer-by-layer synthesis.

**Tata**

The MIT Tata Center for Technology + Design was founded in 2012 with generous support from the Tata Trusts. The Center’s research and education mission is to develop solutions to challenges facing resource-constrained communities globally, with an initial focus on India. Center-affiliated faculty and graduate student Tata Fellows engage in hands-on projects, with an approach that is rigorous and relevant to societal, economic, environmental, and political factors. The Tata Center brings together technical, pedagogical, and organizational expertise from across MIT to provide holistic support to more than 40 projects in the developing world, focused on agriculture, energy, environment, health, urbanization, and water. See page 107 for more information.
Selected Projects

The Future of Food
MITCityFARM, a Media Lab project led by Caleb Harper, employs a methodology that has the potential to reduce water consumption for agriculture by 98%, eliminate chemical fertilizers and pesticides, double nutrient densities and reduce embodied energy in produce by a factor of ten. Harper hopes to catalyze a paradigm shift from traditional practice to resource leveraged and environmentally optimized urban food growing solutions. MITCityFARM exploits innovative research and development of hydroponic, aquaponic and aeroponic production systems, novel environmental, diagnostic and networked sensing, control automation, autonomous delivery and harvest systems, data driven optimization and reductive energy design.

http://www.wired.co.uk/magazine/archive/2014/10/features/server-farm

Programming Materials for Better Design
MIT’s Self-Assembly Lab, directed by Skylar Tibbits, is harnessing the power of computer sciences to program the physical world to assemble and transform itself, taking advantage of the transformational potential of precise material, geometric, and kinetic properties. On a recent project with Airbus, the lab developed a programmable carbon fiber flap to control airflow; the flap automatically opens and closes based on temperature, altitude or pressure as the plane leaves the ground and flies. Such an adaptable component could minimize weight, dispense with the need for a failure-prone electromechanical actuator, and avoid the need for pilots to control it.

http://ilp.mit.edu/newsstory.jsp?id=20909

Body on a Chip Helps Accelerate Drug Discovery
The BIO-MIMETICS program at MIT, led by Linda Griffith, is part of a cooperative agreement between MIT and DARPA, developed to create a versatile microfluidic platform that can incorporate up to 10 individual engineered human microphysiological organ system modules in an interacting circuit. The modules will be designed to mimic the functions of specific organ systems representing a broad spectrum of human tissues, including the circulatory, endocrine, gastrointestinal, immune, integumentary, musculoskeletal, nervous, reproductive, respiratory and urinary systems. The goal of the program is to create a versatile platform capable of accurately predicting drug and vaccine efficacy, toxicity, and pharmacokinetics in preclinical testing.

http://ilp.mit.edu/newsstory.jsp?id=19645

Fiber Made by Transforming Materials
Chong Hou and researchers from fibers@MIT Group are practicing a kind of “alchemy,” turning inexpensive and abundant materials into high-value ones. Drawing thin fibers from bulk materials is nothing new, but the group discovered that when aluminum metal and silica glass are heated and drawn, they react chemically and produce a fiber with a core of pure, crystalline silicon—the raw material of computer chips and solar cells—and a coating of silica. It’s the first time fibers created through this method can have a composition that’s completely different that of the starting materials. Yoel Fink, who leads fibers@MIT, says the technology could open new possibilities for electronics—including solar cells and microchips—to be incorporated into fibers and woven into clothing or accessories.


Raising the IQ of UAVs
Before drone-delivered packages can become a reality, UAVs need to be taught to think for themselves. Nick Roy, former head of Google Inc.’s drone-delivery project, Project Wing, and now director of MIT’s Robust Robotics Group, says that UAVs require more autonomy to avoid collisions and crashes, as well as to understand what’s happening around them. Roy is studying the use of approximation algorithms to surmount computational challenges of fusing and integrating data from multiple sensors. Ultimately, the group hopes to develop sophisticated algorithms to enable UAVs to take instructions from people or collaborate with them.

http://ilp.mit.edu/newsstory.jsp?id=21067
MIT is a leader in conducting research sponsored by industry. Over 200 industrial sponsors supported research projects on the MIT campus in FY2015, with over $119 million in expenditures. Companies often join together in these collaborations to support multi-disciplinary research programs in a wide range of fields.

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2015 (shown in descending order of expenditures)

- MIT Energy Initiative
- Chemical Engineering
- Mechanical Engineering
- Computer Science and Artificial Intelligence Laboratory
- Koch Institute for Integrative Cancer Research
- Media Laboratory
- School of Management
- Center for Transportation and Logistics
- Chemistry
- Aeronautics and Astronautics

MIT Briefing Book
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 44% of all single-sponsored research expenditures and corporate gifts/grants at MIT (FY2014).

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 executives 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.

Office of Sponsored Programs

The Office of Sponsored Programs’ mission is to conduct the centrally organized administrative, business, and financial functions related to award administration and to assist faculty, principal investigators, and their administrators in the identification of resources for and the management of individual sponsored projects consistent both with MIT’s academic and research policies and with the stewardship requirements of and obligations to external sponsors.

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 FY2015

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of invention disclosures:</td>
<td>795</td>
</tr>
<tr>
<td>Number of U.S. new utility patent applications filed:</td>
<td>293</td>
</tr>
<tr>
<td>Number of U.S. patents issued:</td>
<td>314</td>
</tr>
<tr>
<td>Number of licenses granted (not including trademarks and end-use software):</td>
<td>91</td>
</tr>
<tr>
<td>Number of options granted (not including options as part of research agreements):</td>
<td>33</td>
</tr>
<tr>
<td>Number of software end-use licenses granted:</td>
<td>33</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>28</td>
</tr>
</tbody>
</table>
Entrepreneurship
MIT is recognized as one of the most entrepreneurial universities in the world. Its faculty ranks include hundreds of serial startup founders, and its hands-on approach to education encourages students to make a difference in the world by discovering and exploiting new technologies. The science-based ventures coming out of MIT helped transform Kendall Square into a major hub of biotech innovation, and the area thrives today with startups representing an array of industries from energy, to healthcare, to nanotech to advanced manufacturing.

$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.

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.

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.

MIT Startup Exchange
MIT Startup Exchange (STEX) connects industry to startups from across the MIT innovation ecosystem, fostering interactions that lead to strong partnerships. ILP members can engage the STEX community including 1000 active MIT-connected startup companies at all stages of development and representing seven technology clusters: ICT, Biotech, Nanotech, Energy Tech, Advanced Manufacturing, Healthcare, and Hybrid Innovation. STEX runs monthly workshops on topics in technology and innovation including robotics, mobility, biotech, energy, food, and cybersecurity. MIT STEX is a service of MIT’s Industrial Liaison Program (ILP).

Venture Mentoring Service
Venture Mentoring Service (VMS) supports innovation and entrepreneurial activity throughout the MIT community by matching both prospective and experienced entrepreneurs with skilled volunteer mentors. VMS uses a team mentoring approach with groups of 3 to 4 mentors sitting with the entrepreneur(s) in sessions that provide practical, day-to-day professional advice and coaching. VMS mentors are selected for their experience in areas relevant to the needs of new entrepreneurs and for their enthusiasm for the program. VMS assistance is given across a broad range of business activity, including product development, marketing, intellectual property law, finance, human resources, and founders issues. VMS services are offered without charge to MIT students, alumni, faculty and staff in the Boston area.
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
System Design & Management (SDM) is the MIT master’s program in engineering and management. Jointly offered by MIT’s School of Engineering and the Sloan School of Management, SDM educates mid-career professionals to lead effectively and creatively by using systems thinking to solve large-scale, complex challenges in product design, development, and innovation.
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 7
Global Engagement

Singapore 106
Russia 106
India 107
China 107
Middle East 108
Portugal 109
Other Global Initiatives 109
Digital Learning 110
International Study Opportunities 111
MIT International Science and Technology Initiatives 112
International Students 114
International Alumni Entrepreneurs 116
International Alumni 117
International Scholars 118
Selected Projects 119
Campus Research Sponsored by International Organizations 120
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 completed the delivery of 93 courses to SUTD, six more than promised in the collaboration agreement. Additionally, by end of the Spring 2015 semester, MIT faculty will have participated in 43 two-week and 22 four-week co-teaching residencies, which means that MIT is well on the way of fulfilling the required 80 short-term residencies called for in the agreement.

The fourth incoming class at SUTD matriculated in May of 2015, and the first class will graduate at the end of August 2015, a milestone for this fledgling university. In recent years, student exchanges have taken center stage in the collaboration as the third group of Singapore students arrived in this past June for their ten-week Global Leadership Program, and the fourth group of MISTI-Singapore students arrived at SUTD this June to assist in leadership training. In January 2015, a new Winter IAP program was initiated in which 40 SUTD students participated in a three-week program focused on cross-cultural collaboration. As part of the program, the students could choose from 23 new and updated IAP courses developed from MIT-SUTD collaboration funding. 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.

http://sutd.mit.edu/

**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, graduate students, and undergraduate 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 111 for information on Singapore-MIT Undergraduate Research Fellowships.

http://smart.mit.edu/

Russia

**MIT Skoltech Initiative**

In 2011, MIT and Russia initiated a multi-year collaboration to help conceive and launch the Skolkovo Institute of Science and Technology (Skoltech), a new graduate research university in Moscow, focused on a small number of pressing global issues and designed to stimulate the development of a robust innovation ecosystem in Russia. MIT serves as a key collaborator and advisor on programs, structures, policies, and operations in three key domains: research, education, and innovation/entrepreneurship. MIT has helped establish the main elements of Skoltech’s educational programs, including a PhD program and Master of
Science programs in IT, Energy, Space, Design and Manufacturing, and Biomedicine. MIT has helped design and implement a student recruitment strategy and admissions process, and as of Spring 2015 has hosted approximately 75% of all Skoltech Master’s students in Cambridge—for one month to multiple semesters. Part of Skoltech’s effort to address specific real-world problems, which are also of high priority to the Russian Federation, is the establishment of a network of 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 MIT-led CREIs in Biomedicine (RNA Therapeutics and Infectious Diseases), Electrochemical Energy Storage, and in negotiations Energy Systems. Promoting innovation and entrepreneurship is central to Skoltech’s mission. Toward that end, MIT has helped develop an entrepreneurship and innovation curriculum designed to provide foundational understanding in an action-based learning environment for Skoltech students, and has helped build the administrative and operational foundations for knowledge transfer and commercialization of emerging technologies.

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

India

Tata Center for Technology and Design
The Tata Center for Technology and Design at MIT applies deep technical knowledge to the challenges of the developing world, particularly India, and provides holistic technical, educational, and financial support to MIT faculty and graduate students who are engaged with these challenges. Founded in 2012, the Center’s work is made possible by a donation from the Tata Trusts, one of India’s oldest philanthropic organizations.

The students, known as Tata Fellows, develop thesis projects that respond to large-scale opportunities to improve the lives of people in the lower strata of Indian society. These projects are chosen and developed with an emphasis on practicality, impact, and scalability within six overlapping focus areas: agriculture, energy, environment, health, urbanization, and water. The Center is currently supporting 59 Tata Fellows who are enrolled in Master’s and PhD programs across the Institute. So far, five new classes have been established at MIT with Center funding, with more planned for next year, and over 100 members of the MIT community, including Fellows, faculty and staff spend time in India advancing their projects each year.

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 & 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. And starting fall 2015, MIT-CETI will start collaborations with the MIT Samuel Tak Lee Real Estate Entrepreneurship Lab to send CETI teams to Chinese universities to introduce socially responsible entrepreneurship practices in areas of urban planning and real estate.

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 is a medium for knowledge joint-creation, 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—database management, Arabic language technology, new paradigms for social computing, and data visualization, etc.—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. Scientists at QCRI are benefiting from the expertise of MIT’s eminent faculty and researchers 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

Established at MIT, in the year 2005, the Kuwait-MIT Center for Natural Resources and the Environment (CNRE) brings 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 the areas of Energy, Water and the Environment between MIT and institutions in Kuwait. CNRE sponsors a number of programs including grants to support collaborative research, and visitor exchange programs for Visiting Students, Visiting Scientists, and Postdoctoral Fellows.

The Center is funded by the Kuwait Foundation for the Advancement of Sciences (KFAS). Its leadership team consists of Associate Director: Prof. Jacopo Buongiorno of NSE; and Executive Director: Dr. Murad Abu-Khalaf.

http://cnre.mit.edu/
Global Engagement

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 93 outstanding faculty and over 500 graduate students. MIT and Masdar Institute have collaborated on 70 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/

Portugal
MI 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 and venture activities. 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.

http://web.mit.edu/mit-mi-cp/

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 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 200 graduate students are enrolled annually in the various SCALE supply chain educational programs; many of which include a three week student and faculty exchange at MIT. The SCALE Network also features partnerships with over 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.

http://cau.mit.edu/
Digital Learning

OpenCourseWare and MITx represent MIT’s largest and most far-reaching international outreach programs. With more than 2200 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 200 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 the Institute’s interactive learning initiative that offers online versions of MIT courses on edX, a partnership in online education between MIT and Harvard University. MIT instructors teach these MITx courses, called “MOOCs,” to learners around the world.

Learners 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, there have been more than 2.7M enrollments in MITx courses, with nearly 1.6 million participants (some people register for a course but then fail to follow through with any studies or use of course materials). Individual registrants come from more than 200 different countries.

Using the resources, platform, and pedagogical innovations of MITx, faculty also develop digital learning courses and modules for use in on-campus education.
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; 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 Nuclear Science and Engineering has an exchange program with the 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, NUS, and SUTD 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 and still graduate from MIT on time at the following universities: l’École Polytechnique in France, the London School of Economics in the UK, the University of New South Wales in Australia, and Tsinghua University in China. Students may also apply to study abroad programs administered by other U.S. institutions or outsider provider programs.
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 700 MIT students with internship, teaching, research and entrepreneurial 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, Portugal, 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.

http://misti.mit.edu

Here are a few examples from the more than 5,500 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.
- Physics major Jason Brylawskyj 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.

MISTI Excellence Awardee Ricardo De Armas (MechE, 2015) and MISTI Director Professor Chappell Lawson.
MISTI Programs and Start Year

- Arab World, 2014
- 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
- Portugal, 2014
- Russia, 2012
- Singapore, 2012
- South Africa, 2012
- Spain, 2006
- Switzerland, 2010

In 2014–2015, there were MISTI placements in thirty-seven countries.

MISTI Annual Internship Placements
1994–2015*

*MISTI year runs from September 1–August 31. 2015 represents the 2014–2015 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

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>62</td>
</tr>
<tr>
<td>South Korea</td>
<td>28</td>
</tr>
<tr>
<td>Canada</td>
<td>23</td>
</tr>
<tr>
<td>India</td>
<td>21</td>
</tr>
<tr>
<td>Thailand</td>
<td>20</td>
</tr>
<tr>
<td>Brazil</td>
<td>19</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>14</td>
</tr>
<tr>
<td>Mexico</td>
<td>12</td>
</tr>
<tr>
<td>Singapore</td>
<td>9</td>
</tr>
<tr>
<td>Taiwan</td>
<td>9</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>9</td>
</tr>
</tbody>
</table>

### International Graduate Students
Top Countries of Citizenship, 2014–2015

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
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<tr>
<td>India</td>
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<tr>
<td>Canada</td>
<td>239</td>
</tr>
<tr>
<td>South Korea</td>
<td>204</td>
</tr>
<tr>
<td>France</td>
<td>89</td>
</tr>
<tr>
<td>Singapore</td>
<td>84</td>
</tr>
<tr>
<td>Mexico</td>
<td>67</td>
</tr>
<tr>
<td>Taiwan</td>
<td>67</td>
</tr>
<tr>
<td>Germany</td>
<td>67</td>
</tr>
<tr>
<td>Israel</td>
<td>67</td>
</tr>
<tr>
<td>Japan</td>
<td>62</td>
</tr>
</tbody>
</table>

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

![Graph showing international students by geographic region from 1884 to 2015](image-url)
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 hautes 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, 2014 through June 30, 2015, The International Scholars Office (ISchO) served 2,403 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 4 percent over last year (2,305). According to the most recently published Institute of International Education Open Doors report (2014), MIT ranked 11th nationally with regard to the numbers of international scholars at U.S. institutions. Postdoctoral associates and postdoctoral fellows accounted for 59 percent of MIT’s international scholars.

Foreign national scholars came to MIT from 93 different countries, with the highest numbers coming from China, South Korea, India, Germany, Canada, Japan, Italy, Israel, Spain and the UK. 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 64 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.

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>445</td>
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<tr>
<td>South Korea</td>
<td>177</td>
</tr>
<tr>
<td>India</td>
<td>161</td>
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<tr>
<td>Germany</td>
<td>144</td>
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<tr>
<td>Canada</td>
<td>142</td>
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<tr>
<td>Japan</td>
<td>126</td>
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<tr>
<td>Italy</td>
<td>101</td>
</tr>
<tr>
<td>Israel</td>
<td>100</td>
</tr>
<tr>
<td>Spain</td>
<td>80</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>73</td>
</tr>
</tbody>
</table>

International Scholars by Geographic Region, 2014–2015

- Asia: 43%
- Europe: 36%
- Latin America & Caribbean: 5%
- North America: 6%
- Middle East: 7%
- Africa: 2%
- Oceania: 1%
- Middle East: 6%

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 64 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.
Selected Projects

A cheaper, high-performance prosthetic knee
In the last two decades, prosthetic limb technology has grown by leaps and bounds. Today, the most advanced prostheses incorporate microprocessors that work with onboard gyroscopes, accelerometers, and hydraulics to enable a person to walk with a normal gait. Such top-of-the-line prosthetics can cost more than $50,000. Amos Winter is aiming to develop a passive, low-tech prosthetic knee that performs nearly as well as high-end prosthetics, at a fraction of the cost.

Winter and his colleagues have taken a significant step toward that goal. In a paper published in IEEE’s *Transactions on Neural Systems and Rehabilitation Engineering*, the team reports that it has calculated the ideal torque that a prosthetic knee should produce, given the mass of the leg segments, in order to induce able-bodied kinematics, or normal walking.

Using the paper’s results, the group has built a prototype of a prosthetic knee that generates a torque profile similar to that of able-bodied knees, using only simple mechanical elements like springs and dampers. The team is testing the prototype in India, where about 230,000 above-knee amputees currently live.

The paper’s co-authors include graduate student Murthy Arlekatti and Yashraj Narang, a PhD student at Harvard University. This research was funded, in part, by the Tata Center For Technology and Design, the Tata Trust, and the National Science Foundation.


Making clean, high-quality fuels from low-quality oil
New findings released by MIT researchers could help energy companies implement a long-recognized process for converting heavy, high-sulfur crude oil into high-value, cleaner fuels such as gasoline without using hydrogen—a change that would reduce costs, energy use, and carbon dioxide emissions. The process involves combining oil with water under such high pressures and temperatures that they mix together, molecule by molecule, and chemically react. The researchers have produced the first detailed picture of the reactions that occur and the role played by the water in breaking apart the heavy oil compounds and shifting the sulfur into easily removable gases. They have also formulated models that show how best to mix the oil and water to promote the desired reactions—critical guidance for the design of commercial-scale reactors.

“Testing designs and operating conditions at large scale and extreme pressures is almost impossible,” Ghoniem says. “Our goal is to provide computer models that companies can use to predict performance before they start building new equipment.” This research was supported by Saudi Aramco, a founding member of the MIT Energy Initiative.


New insights into carbon emissions in China
Researchers from MIT and Tsinghua University in Beijing are collaborating to bring new insights into how China—the world’s largest emitter of carbon dioxide (CO₂)—can reverse the rising trajectory of its CO₂ emissions within two decades. They use a newly developed global energy-economic model that separately represents details of China’s energy system, industrial activity, and trade flows. The researchers conclude that by designing and implementing aggressive long-term measures now, Chinese policy makers will put the nation on a path to achieve recently pledged emissions reductions with relatively modest impacts on economic growth.

China pledged to turn around the constant growth in its CO₂ emissions by 2030 and to increase the fraction of its energy coming from zero-carbon sources to 20 percent by the same year—approximately double the share it has achieved so far. “To meet its new 2030 targets, China will need to take aggressive steps, including introducing a nationwide price on carbon emissions as well as preparing for the safe and efficient deployment of nuclear and renewable energy at large scale,” says Valerie J. Karplus, assistant professor of global economics and management at the MIT Sloan School of Management and director of the Tsinghua-MIT China Energy and Climate Project. “But with strong action, China’s targets are credible and within reach.”

## Campus Research Sponsored by International Organizations

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

**Fiscal Years 2011–2015**

<table>
<thead>
<tr>
<th>International Sponsor Type</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations and other nonprofits</td>
<td>20,233,545</td>
<td>25,025,346</td>
<td>29,381,412</td>
<td>35,830,415</td>
<td>36,301,791</td>
</tr>
<tr>
<td>Government</td>
<td>32,471,318</td>
<td>37,712,878</td>
<td>32,651,167</td>
<td>28,803,960</td>
<td>26,712,520</td>
</tr>
<tr>
<td>Industry</td>
<td>45,603,282</td>
<td>48,133,890</td>
<td>41,922,158</td>
<td>42,127,804</td>
<td>47,606,652</td>
</tr>
<tr>
<td>Total</td>
<td>98,308,146</td>
<td>110,872,115</td>
<td>103,954,737</td>
<td>106,762,179</td>
<td>110,620,964</td>
</tr>
</tbody>
</table>

| Constant dollars*                | 105,240,028|115,311,422|106,347,034|107,539,385|110,620,964|

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2015 equaling 100.*
Section 8
Service to Local and World Communities

Public Service Center 122
Office of Government and Community Relations 123
Office of Digital Learning 124
Abdul Latif Jameel Poverty Action Lab 124
Local Programs 125
World Programs 126
Selected Projects 128
Service to Local and World Communities

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 MIT Public Service Center (PSC) helps MIT achieve its mission of working wisely, creatively, and effectively for the betterment of humankind. Through its programs, they provide encouragement, advice, logistical support, and funding to help students engage in meaningful and effective public service projects, working with communities in the greater Boston area, throughout the United States, and around the world.

The PSC goal is to enrich the MIT education for students through hands-on, real-world opportunities that complement the innovative culture of MIT. PSC programs (described below) are designed to help students apply classroom learning, develop new skills, and understand the complexities of resolving community challenges.

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

PSC Fellowships Program

MIT students tackle a great variety of human and environmental challenges in communities around the world through this program. Participating students build their skills and reflect on their experiences to enhance classroom learning. Students can work individually or as part of a team on projects during IAP, summer, and the academic year. This past year, 45 PSC fellows tackled some of the most pressing issues in the United States and abroad, working in sectors such as agriculture, water and sanitation, climate change, community development, assistive technology, education, environmental sustainability, food and agriculture, health and health technology, technology dissemination, and urban planning.

IDEAS Global Challenge

Through this annual innovation and social entrepreneurship competition, students form teams to work with a community partner to design and implement innovative projects that improve the quality of life in communities around the world. In 2015, grants were awarded to 11 teams working in sectors such as energy, mobile technology, health and medical devices, water and sanitation, education, and agriculture. Winners of last year’s awards continue to advance their ideas, including testing a malaria diagnostic device, altering cell behavior to fight diabetes, and creating simple-to-read maps for the placement of electrical microgrids in rural areas.

ReachOut

Through this semester-long program, MIT students help Cambridge children foster a love of reading and mathematics. This past winter, two ReachOut tutors helped with program development for East End House’s growing middle school program. During the spring semester, 29 MIT student tutors helped children with math and reading in the local community at our two partner sites, East End House and Cambridge Community Center.

Community Service Work-Study

This program enables MIT students to give back to the community while earning a paycheck during the semester, summer, or winter break. Students who qualify for Federal work-study are able to add to their work experience while assisting nonprofit organizations with finding creative solutions to the problems they face. In spring 2015, work-study students staffed a local homeless shelter, created communication materials for a lead-poisoning prevention program, served as advocates for low-income clients, and tutored Boston high school athletes. Through a partnership between Community Service Work-Study and the Externship program, four students traveled to Los Angeles this past winter to design material for a STEM program with the i.am.angel Foundation.
CityDays
Since July 2014, CityDays events have engaged hundreds of MIT students, staff, and faculty with the local community. Many of the volunteers participated in multiple CityDays events, and PSC developed relationships with active student groups on campus. Sports teams, living communities, service groups, and fraternities and sororities have all participated.

Four Weeks for America
This program enables MIT students to spend IAP working with Teach for America teachers on science and math projects in classrooms in small rural areas or big inner cities while learning about educational change and policy. In 2015, 13 MIT undergraduate students worked as classroom assistants for new STEM teachers and provided all types of support from in-classroom help and after school tutoring to curriculum development and classroom data analysis. Several students worked on additional projects including a renewable energy science fair, a college exposure and admissions program, and innovative lab experiments.

Alternative Spring Break
Alternative Spring Break enables MIT students to spend spring break participating in service in various locations around the country. In March 2015, 23 MIT students participated in three projects. One group went to Crotched Mountain School in New Hampshire, where MIT students worked with children with severe disabilities. Another group went to the Center for Environmental Transformation in Camden, NJ, where MIT students worked with a variety of community organizations on sustainable agriculture and community development. The third group participated in PSC’s CityWeek, in partnership with the local community center Margaret Fuller House. MIT students stayed on campus and spent their days tutoring children, cleaning the center, and learning about this multifaceted and exceptional community resource right outside MIT’s campus.

LEAP Grants
Learn, Explore, Act, & Prepare (LEAP) Grants provide MIT students with funding to carry out a service project, volunteer day, or philanthropy event in the United States. LEAP grants allow students learn about service and social responsibility or build their skills to tackle a community challenge.

Freshman Urban Program
Through this week-long freshman pre-orientation program, incoming MIT students can help others while exploring their new neighborhood, learning about community challenges, and making friends. Last year, the program introduced 26 incoming students to MIT and the surrounding community through service activities and the discussion of social issues. The program also engaged 11 upperclassmen as counselors and coordinators. Freshman Urban Program participants volunteered with 16 agencies—such as the Charles River Conservancy and Bridge over Troubled Waters—and explored how issues like hunger and homelessness affect our 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 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 (ODL) advances MIT's longstanding tradition of service to society with collaborations that bring technology-enabled pedagogical innovation to classroom education and online learning at home and abroad. Primarily through its Strategic Education Initiatives unit, ODL engages with institutions and governments at many levels to help strengthen teaching and learning in a variety of settings.

Massachusetts Community College Project

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 (TAACCCCT) 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.

MIT-Woodrow Wilson Academy of Teaching and Learning

The MIT pre-K-through-12 (“PK12”) Initiative in ODL, with collaborators across MIT, is designed to combine MIT's mens et manus approach to learning with recent breakthroughs in cognitive science and digital learning to help develop and support excellent STEM (Science, Technology, Engineering, Math) teachers and school leaders. The PK12 initiative was launched through the work of a faculty group, facilitated by ODL, which articulated the foundational principles for this effort: To change the world through learning with access to quality STEM education for all, and to change the world of learning through rigorous research. The PK12 Initiative has been bootstrapped by $9.9 million in seed funding from the Woodrow Wilson National Fellowship Foundation for collaboration aimed at supporting teachers in their efforts to use emerging digital learning tools and environments, especially in STEM areas. The effort will promote new ideas, technologies, and curricula along with research related to educator preparation with a focus on STEM subjects for students from pre-kindergarten through the senior year of high school.

Abdul Latif Jameel Poverty Action Lab

The Abdul Latif Jameel Poverty Action Lab (J-PAL) is a global network of over 120 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’s mission is to reduce poverty by ensuring that policy is informed by scientific evidence. We do this through three main activities: (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 eight sector areas, including Agriculture, Crime & Criminal Justice, Education, Environment & Energy, Finance & Microfinance, Health, Labor Markets, and Political Economy & Governance.
**Research**

J-PAL affiliates have conducted more than 600 randomized evaluations in over 60 countries. Recent research by J-PAL affiliates includes: an evaluation by Banerjee (MIT), Duflo (MIT), Glennerster (J-PAL), and Kinnan (Northwestern) on the impact of increased access to microcredit on the economic and social well-being of women and their families in India; a six-country study by Banerjee (MIT), Duflo (MIT), Goldberg (IPA), Karlan (Yale), Osei (University of Ghana), Pariente (Princeton), Shapiro (Princeton), Thuysbaert (Ghent University), and Udry (Yale) that found that a comprehensive livelihood program for the poor was a cost-effective and lasting way to boost livelihoods, income, and health; and 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.

**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 6,000 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 environmental audit reforms, school-based deworming, remedial education, free insecticidal bednets, chlorine dispensers for safe water, skills training for police officers, 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 200 million people.

**J-PAL North America**

J-PAL North America (NA), one of J-PAL’s six regional offices, is also based at MIT. J-PAL NA works to improve lives by ensuring that policy in the region is informed by scientific evidence. J-PAL NA collaborates with decision-makers at the city, state, and federal level, and with a variety of social organizations, to share policy lessons, conduct trainings, and encourage evaluation. J-PAL NA’s work spans a wide variety of areas including: Crime Prevention, Education, Energy Conservation, Financial Literacy, Health Care Delivery, Housing Mobility, Labor Markets, and Political Participation. J-PAL affiliates are conducting or have completed over 110 randomized evaluations in the region. J-PAL NA is led by two Co-Scientific Directors: Amy Finkelstein (Ford Professor of Economics, MIT) and Lawrence Katz (Elisabeth Allison Professor of Economics, Harvard University).

**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.

http://www.cambridgesciencefestival.org/
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.

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

Comprehensive Initiative on Technology Evaluation
The Comprehensive Initiative on Technology Evaluation (CITE) at MIT is the first-ever program dedicated to developing methods for product evaluation in global development. CITE evaluates products’ suitability, scalability, and sustainability, and seeks to integrate these criteria to develop a deep understanding of what makes products successful in emerging markets. CITE’s evaluations provide evidence for data-driven decision-making by development workers, donors, manufacturers, suppliers, and consumers themselves. CITE is a five-year program funded by USAID’s Global Development Lab and led by the Department of Urban Studies and Planning.

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 (2019 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. In addition to its course offerings and fieldwork, D-Lab is home to research groups including the Biomass Fuel and Cookstoves Group, the Mobile Technology Group, and the Off-Grid Energy Group. D-Lab has also spearheaded an initiative called Lean Research, promoting principles for human-centered research. 

http://esp.mit.edu/  
http://cite.mit.edu/  
http://d-lab.mit.edu/
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 2316 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. Research and development work focuses on solar lighting, biomass fuel and cookstoves, water transportation and storage, and agriculture. In the fall of 2014, D-Lab Scale-Ups launched 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. Each year since 2012, Scale-Ups has lead the organization of the MIT Scaling Development Ventures conference.
http://d-lab.mit.edu/scale-ups/overview/

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 over 54,200 inventors, technologists, and social entrepreneurs from almost 530 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), Singapore Polytechnic, the ECHO East Africa Impact Center (Tanzania), and the National Technology Business Center (Zambia), as well as three IDIN innovation centers in Brazil, Uganda, and Tanzania.
http://d-lab.mit.edu/идин/

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/
Selected Projects

Powering desalination with the sun
When Natasha Wright began her MIT PhD program, she had no idea how to remove salt from groundwater to make it more palatable, nor had she ever been to India, where this is an ongoing need. Now, three years and six trips to India later, this is the sole focus of her work.

Wright joined the lab of Assistant Professor Amos Winter with the vague project aim: Work on water treatment in India, with a possible focus on filtering biological contaminants from groundwater to make it safe to drink.

There are already a number of filters on the market that can do this, and during a trip to India, Wright interviewed villagers, finding that many of them weren’t using these filters. Although the filters made water safe to drink, they did nothing to mitigate its saltiness—so the villagers’ drinking water tasted bad and provided little motivation to use these filters.

Almost 60 percent of India has groundwater that’s noticeably salty, so later, after returning to MIT, Wright began designing an electrodialysis desalination system, which uses a difference in electric potential to pull salt out of water. This type of desalination system has been around since the 1950s, but is typically only used municipally, to justify its costs. Wright’s project aims to build a system that’s scaled for a village of 5,000 people, runs on solar power, and is still cost-effective. Since her system is powered by the sun, operational and maintenance costs are fairly minimal: The system requires an occasional cartridge filter change, and that’s it.

Wright’s team won a grant from the United States Agency for International Development (USAID), enabling the researchers to test this system at full scale for the first time in New Mexico.


Empowerment through mobile technology and co-design
“Far and away the best prize that life has to offer is the chance to work hard at work worth doing,” Theodore Roosevelt once said in a speech in 1903. MIT senior in computer science Beth Hadley takes these words to heart. She has been a pivotal force behind InstaAid, an iPad application that enables residents at The Boston Home (TBH) to access assistance from any area of the facility, thus increasing their safety and quality of life.

During the fall of 2014, in the course Principles and Practices in Assistive Technologies, or PPAT, Hadley and her classmates, senior Laura D’Aquilla and junior Tanya Talkar, formed a team with Margaret Marie, a TBH resident, to design an application that transformed the nurse call system at the home. For many residents of the home, calling for help is not a simple task. Most residents have limited mobility due to conditions such as amyotrophic lateral sclerosis (ALS), making it difficult, and many times impossible, to reach the help button wired to the wall. Many residents, however, already use iPads attached to their wheelchairs.

While the first iteration of the application was developed during the PPAT class, Hadley turned it into her senior thesis project and continued to improve it. She tested and revised several prototypes and incorporated feedback from TBH residents and staff throughout, turning an experimental product into a robust and sustainable call system downloadable from the Apple App Store. The application transforms the process of providing help to residents. With two interfaces, one for the resident, and one for the nurse, users can request water, aid, or signal an absolute emergency at the touch of a button, whether they are in their room or even away from the home’s premises. The custom notification helps nurses identify real emergencies and dispatch the right personnel for each call.

InstaAid is one of the first mainstream mobile communication technology that meets the dynamic communications needs of differently-abled individuals—the interface is designed to accommodate for visual, motor, and cognitive challenges.

http://news.mit.edu/2015/empowerment-through-mobile-technology-and-co-design-0518