MIT Briefing Book

Massachusetts Institute of Technology

MIT Briefing Book

Researched and written by the MIT News Office and the Government and Community Affairs Office, with the assistance of many other offices, particularly the Planning, Sponsored Research, Student Financial Aid, and the Washington Offices.

Executive Editors
Kenneth Campbell and Ronald Suduiko

Editor, Computer Support
Gabriel Rockefeller

Information, Charts
Lydia Snover and Kenneth Campbell

Photography
Donna Coveney

Design
Celia Metcalf

Production
Joan McCandlish
Allison Associates, Boston

Printing
MIT Copy Technology Centers

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MIT Washington Office

The MIT Washington Office was established in 1991 as part of the President's Office.

Staff

John C. Crowley
Director

Tobin L. Smith
Assistant Director

Carolyn M. Hanna
Legislative Assistant

Christine L. McGrew
Administrative Secretary

Address and Phone

MIT Washington Office
820 First Street, NE, Suite 410
Washington, D.C. 20002

Phone: 202-789-1828
Fax: 202-789-1830
E-mail: JCROWLEY@MIT.EDU or
TOBY@MIT.EDU

MIT and Massachusetts

People	Total, MIT-affiliated people in state:	36,270
	Employees:	9,880
	Cambridge campus	(7,830)
	Lincoln Laboratory	(2,050)
	Students:	9,947
	Alumni/ae in Massachusetts:	16,440
Economic	Total MIT budget in FY 96:	$1.36 billion
	Total Research Projects: (FY 96)	$708 million
	Federal Research Projects (MIT FY 96):	$610 million
	Cambridge campus	($272 million)
	Lincoln Laboratory	($338 million)
	Other Research:	$98 million
	Payroll:	$395 million
	Purchases in the state:	$209 million

Spin-offs and Start-ups

MIT graduates, faculty and staff have founded 4,000 firms which, in 1994 alone, employed at least 1.1 million people and generated $232 billion of world sales. Massachusetts in 1994 had 1,120 MIT-related firms employing 125,000 in the state and 361,000 worldwide with world sales of $54.6 billion. See Page 5-2.

The MIT Technology Licensing Office since 1984 has licensed MIT technology to 114 start-up companies.

Cost Cutting

MIT's reengineering project was begun in 1994 to simplify administrative processes while improving quality, enhancing customer responsiveness, and reducing costs. A new, centrally located Student Services Center handling a wide variety of transactions opened in August, 1997. MIT has also consolidated suppliers, streamlined facilities operations, revamped the campus mail delivery system, and is installing a new financial system.

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MIT Facts and History

The Massachusetts Institute of Technology, in Cambridge, Mass., was founded in 1861 by William Barton Rogers and admitted its first students in 1865. The event marked the culmination of an extended effort by Rogers, a distinguished natural scientist, to establish a new kind of independent educational institution relevant to an increasingly industrialized America.

According to its charter, MIT was established as “a school of industrial science, and aiding generally, by suitable means, the advancement, development and practical application of science in connection with arts, agriculture, manufactures and commerce.” Rogers stressed the pragmatic and practicable. He believed that professional competence was best fostered by coupling teaching and research and by focusing attention on real-world problems. Toward this end, he pioneered the development of the teaching laboratory.

MIT has held to Rogers’ vision in the development of the Institute and today MIT is one of the world’s outstanding universities. The Institute offers internationally renowned programs and its faculty and staff are called upon by leaders around the world for guidance. Education and research — with relevance to the practical world as a guiding principle — continue to be its primary purpose. MIT is the only private U.S. university that is a land grant, sea grant and space grant institution. MIT is independent, coeducational and privately endowed.

Students

The Institute's student body of 9,947 is a highly diverse group. Students come from all 50 states, the District of Columbia, three territories and 104 foreign countries — some of the best and brightest from the United States and abroad. Fewer than one-quarter of the students who apply are accepted for admission as undergraduates. Forty-five percent of the undergraduates and 14 percent of graduate students are members of U.S. minority groups. The broad international student representation of 2,144 students makes up 8% of the undergraduate and 33% of the graduate population. MIT is 31st among the nation's colleges and universities in the number of foreign students in its student population, according to the National Science Foundation (report #93-302). Countries represented at MIT include Canada, 223; China, 207; Japan, 119; Korea, 104; India, 103; Mexico, 74; Thailand, 63; Taiwan, 57; Germany, 54; Brazil, 53; France, 52; Italy, 52; Singapore, 52; Greece, 50; and Argentina, 49.

Thirty-five percent of MIT's first year students were number one in their high school class.

Student Body Profile (1996–1997)

Undergraduate	4,429	
Graduate	5,518	
Total	9,947 students	
Undergraduate	39% female	61% male
Graduate	24% female	76% male

Members of U.S. minority groups: 2,755

	Undergraduate	Graduate
African American	286	136
Asian American	1,253	437
Hispanic American	427	139
Native American	33	8
	1,999 (45%)	756 (14%)

(These figures may not precisely reflect the population because they are self-reported and not all students choose to provide this information.)

Alumni and Alumnae

MIT's 90,000 alumni and alumnae are connected to the Institute through over 96 local clubs as well as through their graduating classes and departmental organizations. It is an active group, with 4,000 graduates volunteering their services on committees and the MIT Corporation (board of trustees). MIT graduates are spread out across the world with 87% residing in the U.S.

Faculty, Staff and Trustees

MIT's faculty is renowned for its dedication to undergraduate students and teaching. Together with the staff and administration, there is a strong organization that supports the teaching and research efforts.

The Institute is headed by the president, Charles M. Vest, who reports to the board of trustees, known as the Corporation. This group includes approximately 75 leaders in education, industry, science, engineering and other professions. There are approximately 20 emeritus members.

Faculty/Staff 1996–1997

Faculty	896
Other academic and instructional staff	697
Research staff and research scientists	2,575
Administrative staff	1,239
Support staff	1,487
Service staff	781
Medical staff	150
Senior officers	9
Total Campus Faculty and Staff	7,834

Professor Mario Molina shared the 1995 Nobel Prize in chemistry for showing that chlorofluorocarbon (CFC) gases in spray cans and air conditioners can imperil the fragile ozone layer that protects the world from dangerous ultraviolet radiation of the sun.

In addition, 666 graduate students serve as teaching assistants or instructors and 2,092 graduate students serve as research assistants.

MIT Lincoln Laboratory employs about 2,050 people in its work, principally at Hanscom Air Force Base in Lexington, Massachusetts.

Faculty Profile

71 percent tenured
309 endowed professorships

Faculty Honors:
11 Nobel Prizes (4 are retired)
209 American Academy of Arts and Sciences
86 National Academy of Engineering (38 are retired)
98 National Academy of Sciences (47 are retired)
20 Institute of Medicine (6 are retired)
8 National Medals of Science (6 are retired)
1 Pulitzer Prize
4 Kyoto Prizes (3 are retired)
1 Japan Prize

Degrees

MIT awarded 2,280 degrees in 1997:
247 doctorate degrees
999 master's degrees
11 professional engineer degrees
1,023 bachelor of science degrees

Fields of Study

At MIT there is a large variety of fields of study, from science and engineering to the arts. Many interdepartmental programs, laboratories and centers cross traditional boundaries and encourage creative thought and research. There are five academic schools at MIT, organized into departments and a variety of other degree-granting programs. In addition, there are several interdisciplinary programs that offer degrees.

School of Architecture and Planning
Architecture
Program in Media Arts and Sciences
Urban Studies and Planning

School of Engineering
Aeronautics and Astronautics
Chemical Engineering
Civil and Environmental Engineering
Electrical Engineering and Computer Science
Materials Science and Engineering
Mechanical Engineering
Nuclear Engineering
Ocean Engineering

School of Humanities and Social Science
Anthropology/Archaeology
Economics
Foreign Languages and Literatures
History
Linguistics and Philosophy
Literature
Music and Theater Arts
Political Science
Program in Science, Technology, and Society
Program in Writing and Humanistic Studies

Sloan School of Management
Management

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

Whitaker College of Health Sciences and Technology
Division of Toxicology
Harvard-MIT Division of Health Science and Technology

Interdepartmental Laboratories, Centers and Programs

MIT has more than 100 specialized labs, centers and programs representing a broad range of fields — from manufacturing and productivity to biomedical research to artificial intelligence. These labs bring together faculty, students, and staff from different departments to attack complex problems. Their interdisciplinary focus fosters new creative concepts, many of which result in practical applications.

Many of these centers have helped to establish MIT's reputation for cutting edge research in pursuit of solutions to significant problems. Research has led to developments in new drugs and medical techniques, computing innovations, and the technical basis for much of our national defense.

Aga Khan Program for Islamic Architecture
Artificial Intelligence Laboratory
Bates Linear Accelerator
Biotechnology Process Engineering Center
Center for Advanced Engineering Study
Center for Advanced Visual Studies
Center for Biological and Computational Learning
Center for Biomedical Engineering
Center for Cancer Research
Center for Competitive Product Development
Center for Computational Research in Economics and Management Science
Center for Coordination Science
Center for Energy Policy Research
Center for Entrepreneurship
Center for Environmental Health Science
Center for Industrial Performance
Center for Information Systems Research
Center for International Studies
Center for Learning and Memory
Center for Materials Science and Engineering
Center for Organizational Learning
Center for Real Estate
Center for Space Research
Center for Technology, Policy and Industrial Development
Center for Transportation Studies
Clinical Research Center
Council on Primary and Secondary Education
Decision Sciences Program
Energy Laboratory
Francis Bitter Magnet Laboratory
Haystack Observatory
Industrial Performance Center
International Center for Research on the Management of Technology
International Financial Services Research Center
Laboratory for Computer Science
Laboratory for Electromagnetic and Electronic Systems
Laboratory for Information and Decision Systems
Laboratory for Manufacturing and Productivity
Laboratory for Nuclear Science
Leaders for Manufacturing Program
Materials Processing Center
Media Laboratory
Michigan-Dartmouth-MIT Observatory, Kitts Peak, AZ

Millstone
Nuclear Reactor Laboratory
Office of Educational Opportunity Programs
Operations Research Center
Plasma Science and Fusion Center
Program in Environmental Energy Education and Research
Program on the Pharmaceutical Industry
Research Laboratory of Electronics
Sea Grant College Program
Spectroscopy Laboratory
System Design and Management Program
System Dynamics Group
Technology and Development Program
Technology and Policy Program
Technology, Management and Policy Program
Wallace Observatory
Women's Studies Program

Academic Affiliations

The Charles Stark Draper Laboratory

Formerly MIT's Instrumentation Laboratory, Draper Laboratory became an independently operated, nonprofit research and educational organization in 1973. MIT and Draper Laboratory still collaborate in research and teaching in areas such as: guidance, navigation and control; computer science; data and signal processing; material sciences; integrated circuitry; computational sciences; information systems; and underwater vehicle technologies.

Dibner Institute for the History of Science and Technology and the Burndy Library

Established at MIT in 1992 as a center for advanced research, the Dibner Institute supports the work of resident scholars and graduate students in the history of science and technology. A consortium of MIT, Boston University, Brandeis and Harvard, the Institute's resources include the Burndy library, one of the world's finest collections of historical scientific books, manuscripts, instruments and works of art.

Harvard-MIT Division of Health Sciences and Technology

A major collaboration between Harvard University and MIT, this division of MIT's Whitaker College applies science and technology to human health needs. It directs the complementary strengths of both universities to the education of physicians, medical engineers and medical physicists, and to research on important health and medical problems. A number of the division's interdisciplinary research programs collaborate with faculty at Harvard teaching hospitals. Students in the division may select a program in biomedical sciences leading to an M.D. degree from Harvard Medical School, or may pursue Ph.D. degrees in medical engineering, medical physics, or speech and hearing sciences from MIT or Harvard.

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. Nine HHMI investigators hold faculty appointments at MIT.

Northeast Radio Observatory Corporation

A consortium of twelve universities and institutions in the northeastern United States, this program promotes radio astronomy research. Its principal facility is MIT's Haystack Observatory, in Westford, Massachusetts. The Observatory is also engaged in geodetic research, using Very Long Baseline Interferometry, and in observations of the earth's upper atmosphere, using incoherent scatter radar.

ROTC (Reserved Officer Training Corps) Programs

Air Force, Army and Navy ROTC training programs are run at MIT, serving students from MIT, Harvard and Tufts Universities. Air Force and Army training programs also include Wellesley College students. Military training has existed at MIT since the first students arrived in 1865, and in 1917, MIT established the first Army ROTC unit in the country. Over 12,000 officers have been commissioned from MIT, with more than 150 reaching the rank of general or admiral. These programs provide students with the opportunity to become commissioned military officers upon graduation and may provide scholarship money to pay for their college education.

Whitehead Institute for Biomedical Research

An independent basic research and teaching institution affiliated with MIT, the Whitehead Institute carries out research in developmental biology and the emerging field of molecular medicine. Faculty at the Whitehead Institute teach at MIT, and MIT graduate students conduct research and receive training in Whitehead Institute laboratories.

Whitehead Institute/MIT Center for Genome Research

The Whitehead Institute/MIT Center for Genome Research is the largest genome center sponsored by the National Center for Human Genome Research of the National Institute of Health. Recent achievements include the creation of powerful new maps of the human and mouse genomes; the development of novel automation technologies; and the design of informatics strategies that make the Whitehead/MIT Genome Center's data freely available through the World Wide Web to all interested scientists.

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

MIT and the Woods Hole Oceanographic Institution jointly offer doctor of science and doctor of philosophy degrees in chemical oceanography, marine geology, marine geophysics, physical oceanography, applied ocean science and engineering, and biological oceanography. They also offer master's and professional degrees in some disciplines.

Wellesley-MIT Exchange Program

Through this program, students may cross-register for any courses at the other school, expanding the educational opportunities for participating students. Students also earn, through the Wellesley Education Department, Massachusetts certificates to teach a number of courses at the elementary and secondary level.

Cross-Registration at Other Institutions

MIT has cross-registration arrangements with several area schools, enabling qualified MIT students to take courses at Harvard University, Boston University's African Studies Program, Brandeis University's Florence Heller Graduate School for Advanced Studies in Social Welfare and Tufts University's School of Dental Medicine. MIT also has a junior year abroad program and a domestic year away program where students may study at another institution in the U.S. or abroad.

MIT Teaching Firsts

MIT has long believed that professional competence is best fostered by coupling teaching with research and by focusing attention on real-world problems. This hands-on learning approach has made MIT a consistent leader in the outside surveys of the best college programs in the nation. MIT was the first university in the nation to have a curriculum in these fields: 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 alumni and alumnae are professors at colleges and universities around the world. MIT professors have written some of the best-selling textbooks of all time, such as *Economics* by Paul A. Samuelson. Following are notable milestones in teaching at MIT over the past three decades:

1969: The Undergraduate Research Opportunities Program (UROP), the first of its kind, is launched. The program, which enables undergraduates to work directly with faculty members in professional research, subsequently is copied in many universities throughout the world. In 1996, 2,800 MIT students participated in UROP.

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

1971: MIT holds its first Independent Activities Period, a January program that emphasizes creativity and flexibility in teaching and learning. Over 600 activities are offered including design contests, laboratory projects, workshops, field trips, and courses in practical skills.

1975: MIT's Department of Materials Science and Engineering pioneers a multidisciplinary academic program that combines the study of metallurgy, ceramics and polymers.

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

1981: MIT launches Project Athena, a $70 million program to explore the use of computers in the educational process. Digital Equipment Corporation and IBM each contribute $25 million worth of computers.

1983–1990: The Athena Language Learning Project brings together language teachers and computer scientists to pioneer the development of interactive video to immerse students in the language, cities and character of other cultures. The work sets the standard for a new generation of language learning tools.

1984: The School of Architecture and Planning creates a program in real estate development, the first at the university level in the United States.

1984: MIT establishes the Media Laboratory, bringing together several pioneering educational programs in computer music, film, graphics, holography, lasers, photography, television and other media technologies.

1985: MIT, with a major grant from the National Science Foundation, establishes the Biotechnology Process Engineering Center to train professionals to develop basic concepts for commercial applications of modern biology.

1986: MIT initiates its Freshman Advisor Seminars, combining advising and mentoring with academic instruction designed to engage students in active weekly discussion and hands-on learning.

1991: MIT establishes the MacVicar Faculty Fellows Program, named in honor of the late Professor Margaret A. MacVicar, to recognize outstanding contributions to teaching. Up to eight members of the faculty are selected annually to receive a special fund for ten years to develop new ways to enrich the undergraduate learning experience.

1992: MIT establishes the Laboratory for Advanced Technology in the Humanities to extend its pioneering work in computer/video-assisted language learning to other disciplines, starting with a multi-media archive for the study of the text and performance of Shakespeare's plays.

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 required courses of physics, mathematics, chemistry and the humanities.

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.

MIT Research Firsts

Following are selected research achievements of MIT faculty over the last three decades:

1969: Ioannis V. Yannas begins work on developing 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 in 1975 for Baltimore, provided a new means for studying the structure and function of genes.

1988: Sallie Chisholm uses new technology to find microscopic life form.

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 received the Nobel Prize in 1990 for their work.

1974: Samuel C.C. Ting, Ulrich Becker and Min Chen discover the "J" particle. The discovery, which earned a Nobel Prize for Ting in 1976, points to the existence of one of the six postulated types of quarks.

1975: With the aid of NASA's space shuttles, Laurence Young begins research on the effects of weightlessness on humans. The work provided a basic understanding of motion sickness.

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

1976: Har Gobind Khorana and research team complete chemical synthesis of the first man-made gene fully functional in a living cell. The culmination of 12 years' work, it established the foundation for the biotechnology industry. Khorana won the Nobel Prize in 1968 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.

1977: Ronald L. 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, employs published keys, allows secret communication between any pair of users, and has so far proved unbreakable.

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 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 leading to development of the first diagnostic technetium drug for imaging the human heart. Recent studies have shown that several compounds in this class can locate metastatic breast cancer and other cancers.

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 received the Nobel Prize for similar work on the immune system's B cells.

1986: Stephen Benton and his students at the Media Laboratory invent the alcove hologram that projects a computer-generated 3-D image — an automobile "parked" in mid-air — into space.

1993: Rich and Zhang's protein fragment forms a visible membrane when exposed to a salt solution.

1988: Sallie Chisholm and her associates report they have found a form of ocean plankton that may be the most abundant single species on earth.

1990: Michael Cima successfully adapts the technique called metal organic deposition to use in creating ultra-thin films of superconducting materials.

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

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 associates at MIT.

1993: Three important scientific discoveries are reported at MIT this year. H. Robert Horvitz, along with scientists at Massachusetts General Hospital, discover an association between a gene mutation and the inherited form of Lou Gehrig's disease.

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.

Alexander Rich and post-doctoral fellow Shuguang Zhang report the discovery of a small protein fragment that spontaneously forms into membranes, and is expected to find uses in drug development, biomedical research and in understanding Alzheimer's and other diseases.

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: Scientists at the Whitehead Institute for Biomedical Research and MIT create a map of the human genome that will allow them to 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, headed by Matthew Wilson and Nobel Laureate Susumu Tonegawa, using new genetic and multiple-cell monitoring technologies, 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 of atoms can be focused to a pinpoint or made to travel long distances with minimal spreading. The laser could have a variety of applications in fundamental research and in industry.

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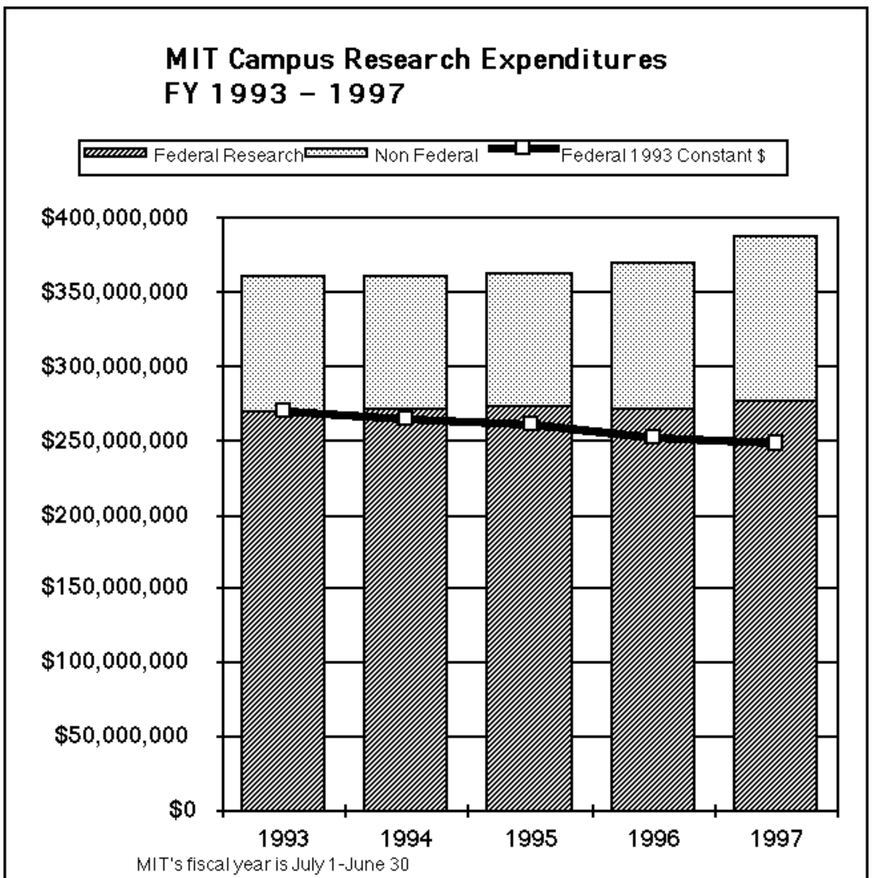
MIT Research Support

MIT is one of the leading research universities in the world. Basic and applied research at MIT is conducted in two principal locations, the MIT campus in Cambridge, Mass. and off-campus at the MIT Lincoln Laboratory, a federally-funded research and development center (FFRDC) in Lexington, Mass.

All research support received by MIT faculty and research staff from federal sources is awarded competitively, based on the scientific and technical merit of proposals. In fiscal year 1997 there were over 1,600 active grants and contracts.

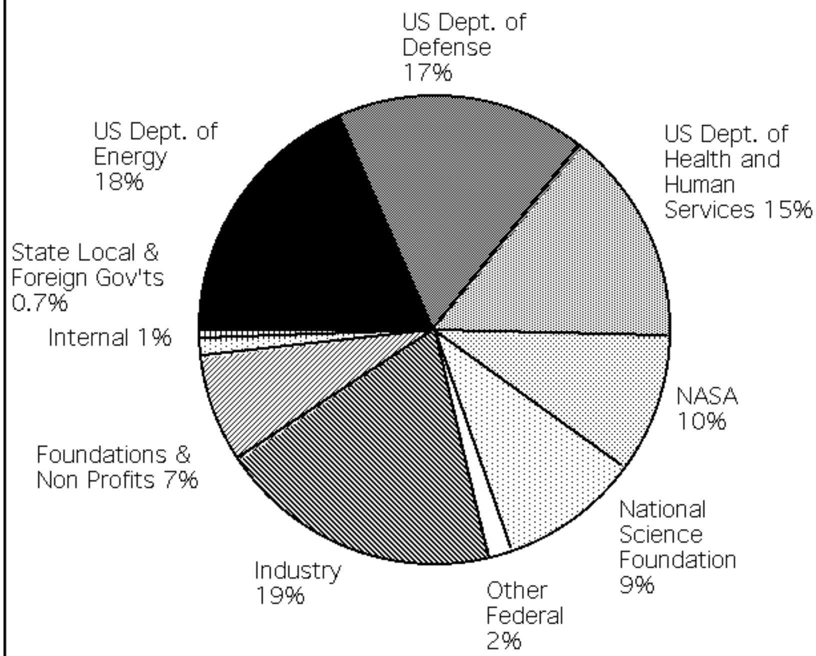
The Charts: The bar graphs for the campus and each major sponsor of research show the amount expended for research projects during MIT's fiscal years (July 1–June 30). The black line represents an adjustment for inflation, based on 1993 dollars.

Campus Research



	1993	1994	1995	1996	1997
Federal Research	$268,206,000	$270,718,000	$273,542,000	$271,544,000	$276,352,000
Non Federal	$93,148,000	$88,956,000	$88,147,000	$98,739,000	$111,528,000
Total Research	$361,354,000	$359,674,000	$361,689,000	$370,283,000	$387,880,000

Campus Research Sponsors FY1994



MIT's fiscal year is July 1 - June 30

Major Sponsor	FY1997 Research Expenditures	% of Total
Department of Energy	$70,753,000	18.2%
Department of Defense	$67,858,000	17.5%
Health and Human Services	$57,215,000	14.8%
NASA	$36,947,000	9.5%
National Science Foundation	$36,347,000	9.4%
Other Federal	$7,232,000	1.9%
Total Federal Research	$276,352,000	71.2%
Industry	$75,194,000	19.4%
Non-Profits	$28,952,000	7.5%
Internal	$4,527,000	1.2%
State Local Foreign Governments	$2,855,000	0.7%
Total Non-Federal Research	$111,528,000	28.8%
Total Research Expenditures	**$387,880,000**	**100%**

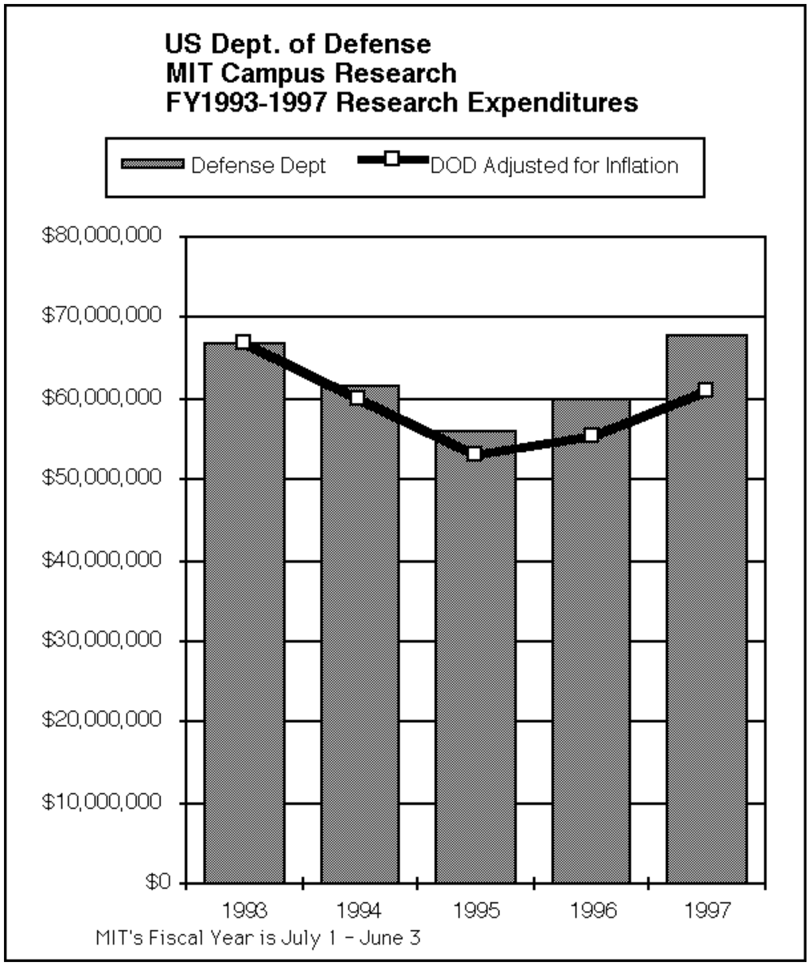
Atom Laser
MIT physicists have created the first atom laser, a device that is analogous to an optical laser but emits atoms instead of light. The new laser could have a variety of applications in fundamental research and in industry. For example, after further developments the atom laser could be used to directly deposit atoms onto computer chips, creating much finer patterns than currently possible. The work was supported by ONR, NSF, the Joint Services Electronics Program (Army Research Office), and the Packard Foundation.

Web Wrapping Services
An MIT project to improve the usefulness of the World Wide Web addresses the fact that the Web is a very human-intensive environment — if you want to find ski areas with more than five feet of snow, for instance, you've got to click and click and read and read. Web Wrapping Services overcomes that problem by automatically superimposing a database-like front end on the Web so you can query all registered Web sites. The work is funded by the Defense Advanced Research Projects Agency; experiments testing the technology are funded by TASC/PRIMARK, TRW, and Merrill Lynch.

Penguin Boat
The penguin uses two flippers to propel its rigid body quickly and efficiently through the water. Now MIT engineers have applied that "technology" to a man-made vehicle. *Proteus* the Penguin Boat has two "oscillating foils," or flippers, attached to its stern. *Proteus* could lead to ships that move more efficiently — and consume less fuel — than those using propellers. The new system when tested in the laboratory reached up to 87 percent efficiency. The average efficiency of existing ships is at or below about 70 percent. The work is supported by ONR and the MIT Sea Grant College Program.

Robot and Human Tactile Perception
This project is an investigation of human and robotic tactile perception and manipulation. Long-term results are aimed at improved robotic systems, a better understanding of human touch perception and a better description of the requirements for human/machine interfaces. This research is sponsored by the Office of Naval Research.

Department of Defense



Department of Defense funding in FY97 was $67.9 million.

Leading Departments, Centers and Laboratories Receiving Defense Department Support (FY1996 figures)*

Laboratory for Computer Science
Research Laboratory of Electronics
Artificial Intelligence Laboratory
Center for Technology Policy and Industrial Development
Aeronautics and Astronautics Department

*Detailed 1997 figures not available at time of printing.

Other Funding

DOD Fellowships are awarded to support graduate students in fields important to national defense needs. For the 1995–96 year, MIT had 58 National Defense Science and Engineering Graduate Fellows, 3 from the Joint Service Electronics Program, 23 from the Office of Naval Research and 7 from the Air Force Laboratory Program.

New Way to Deliver a Shot

This research involves encapsulating a vaccine in microscopic, biodegradable spheres that are injected into the body. Since the microspheres release the vaccine slowly over time, this method eliminates the need for a full course of injections, potentially saving lives of those who don't follow through with the rest of the injections. The work was supported by grants from the World Health Organization and the National Institutes of Health (NIH).

Oil-Eating Bacteria

MIT chemists are studying how certain bacteria consume natural gas and wastes like oil and chlorinated hydrocarbons. Researchers seek to design synthetic systems that do the same thing. Both the natural and synthetic oxygenases will be used to purify chemical waste holding tanks, contaminated water, and other environmentally compromised areas. The work is supported by NIH.

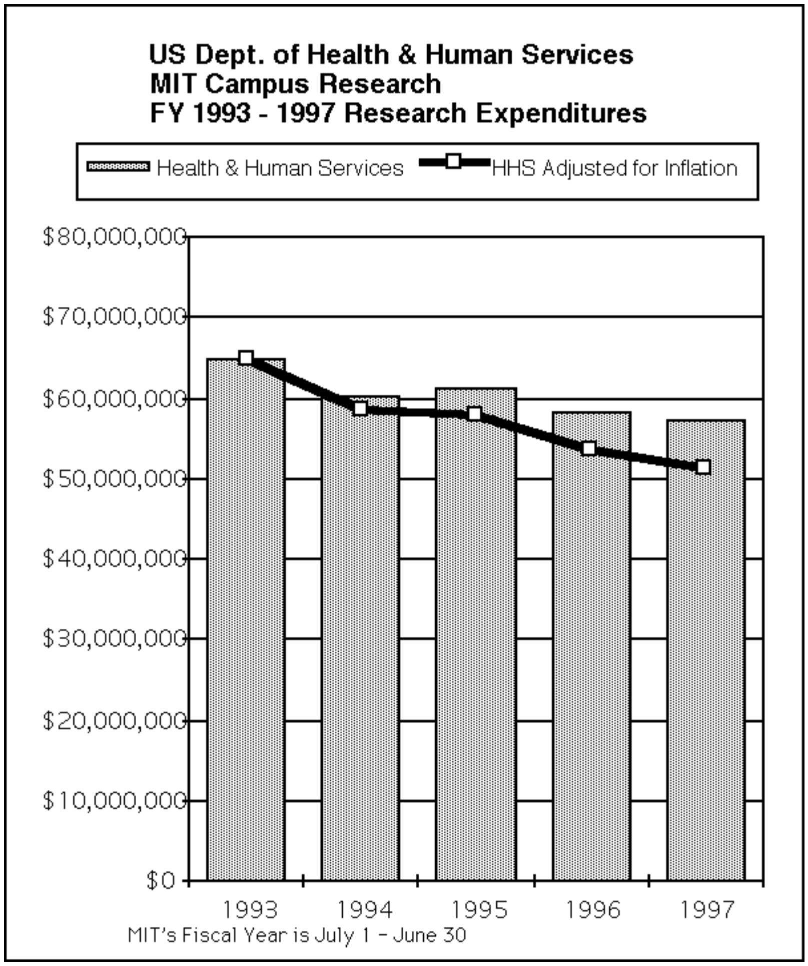
Genetic Link to Memory

Using new genetic and multiple-cell monitoring technologies, MIT scientists have demonstrated how animals form memory for places, which may directly relate to the same ability in humans. This latest "regional gene knockout" technology, through which scientists can develop a breed of mice in which a gene is eliminated in a specific area or only in one particular type of cell, will be valuable in the study of neurological diseases such as Alzheimer's, Huntington's, and drug addictions. The nine-person team at MIT's Center for Learning and Memory obtained evidence showing that strengthened connections between groups or ensembles of neurons enable the formation of internal "maps" of a space which allow the animals to remember that environment, whether it is a room or a pond. The research was supported by the National Institutes of Health, gifts from the Shionogi Institute of Medical Science in Japan, Amgen, Inc., the Seaver Institute and the Sloan Foundation.

Cancer Drug Analysis

Researchers are studying the drug cisplatin — one of the most widely used anti-cancer drugs — to understand how it works so that additional platinum-based anti-cancer drugs can be developed. Cisplatin binds to the DNA in a cancer cell and causes damage to the structure of the DNA. The platinum renders the DNA unable to duplicate itself and spread the cancer. The role of proteins which bind to the damaged DNA is one of the areas of investigation. Cisplatin is widely used to treat testicular and ovarian cancers as well as some cancers of the head and neck.

Department of Health and Human Services



Department of Health and Human Services funding in FY97 was $57.2 million.

Leading Departments, Centers and Laboratories Receiving Health and Human Services Department Support (FY1996 figures)

Biology Department
Center for Cancer Research
Center for Environmental Health Sciences
Chemistry Department
Brain and Cognitive Science Department

Toxic Waste Treated by Plasmas

MIT's Plasma Science and Fusion Center has used plasmas — high-temperature electrically charged conducting gases — to change the chemical composition of toxic wastes into benign substances. The present effort in the waste treatment area is the development of new environmental monitoring technology. There is also a program which involves the use of plasma technology to produce hydrogen-rich gas from hydrocarbon fuels. This program could result in approaches to reduce significantly pollution from power generation systems and vehicles.

CO_2 Cleanup

One possible option for reducing a major source of atmospheric carbon dioxide (CO_2) emissions is to capture and sequester the CO_2 emitted from fossil fuel electric power plants. MIT researchers are looking at potential deep ocean disposal systems. Planning is underway for a Joint Research Program, as part of the Climate Technology Initiative, that will involve Japan, Norway, and the United States in larger-scale collaborations on ocean disposal field experiments.

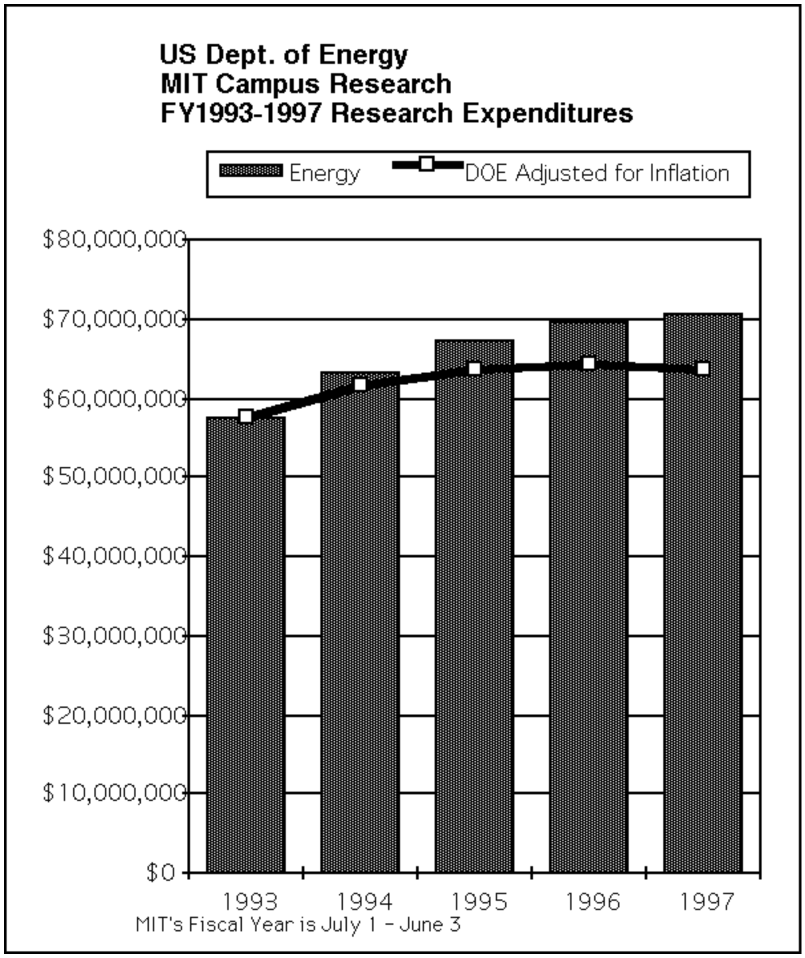
Detecting Cracks in Concrete Structures

MIT researchers and colleagues are designing new optical fiber sensors to detect cracks in concrete structures from bridges to the protective walls surrounding hazardous-waste dumps. In a bridge, the fibers would be embedded in a plastic sheath and glued securely to the bottom of the bridge deck. When a crack forms across a fiber, the fiber will bend, causing a sudden loss in signal as some energy escapes from the fiber core. To detect the cracks, the signal is monitored.

Bates Large Acceptance Spectrometer Toroid

The Division of Nuclear Physics of the Department of Energy has approved funding to begin construction of the Bates Large Acceptance Spectrometer Toroid (BLAST) project at the MIT Bates Linear Accelerator Center in Middleton, MA. BLAST, a detector designed specifically to work in new Bates South Hall Ring, will help an international collaboration of 40 scientists to study the structure of protons, neutrons, and light nuclei.

Department of Energy



Department of Energy funding in FY97 was $70.8 million.

Leading Departments, Centers and Laboratories Receiving Energy Department Support (FY1996 figures)

Plasma Science and Fusion Center
Laboratory for Nuclear Science
Energy Laboratory
Earth, Atmospheric and Planetary Science Department
Materials Science & Engineering Department

National Science Foundation Recent MIT Campus Projects

Audio Notebook

The Audio Notebook is a new tool for rapidly accessing recorded notes. On top of the notebook is a pad of paper. As you take notes, the device records audio while sensors under the pad synchronize your note taking with the recording. When you are reconstructing your notes you can, among other options, touch your pen to a quoted word written on your notepad, and it will start playing back at that very spot. The work is sponsored by the NSF, AT&T, and two consortia at the MIT Media Lab.

Environmentally Friendly Gases

Key to making computer chips and other products of the microelectronics industry are gases known as perfluorocompounds (PFCs). PFCs, however, are suspected of contributing to global warming. As a result, scientists are exploring options toward reducing their use. MIT researchers and colleagues are tackling one approach. They are looking for alternative gases that could do the same job but are environmentally more benign. The MIT team has found a few chemicals that look promising. The work is funded by the NSF-SRC (Semiconductor Research Corporation) Engineering Research Center for Environmentally Benign Semiconductor Manufacturing.

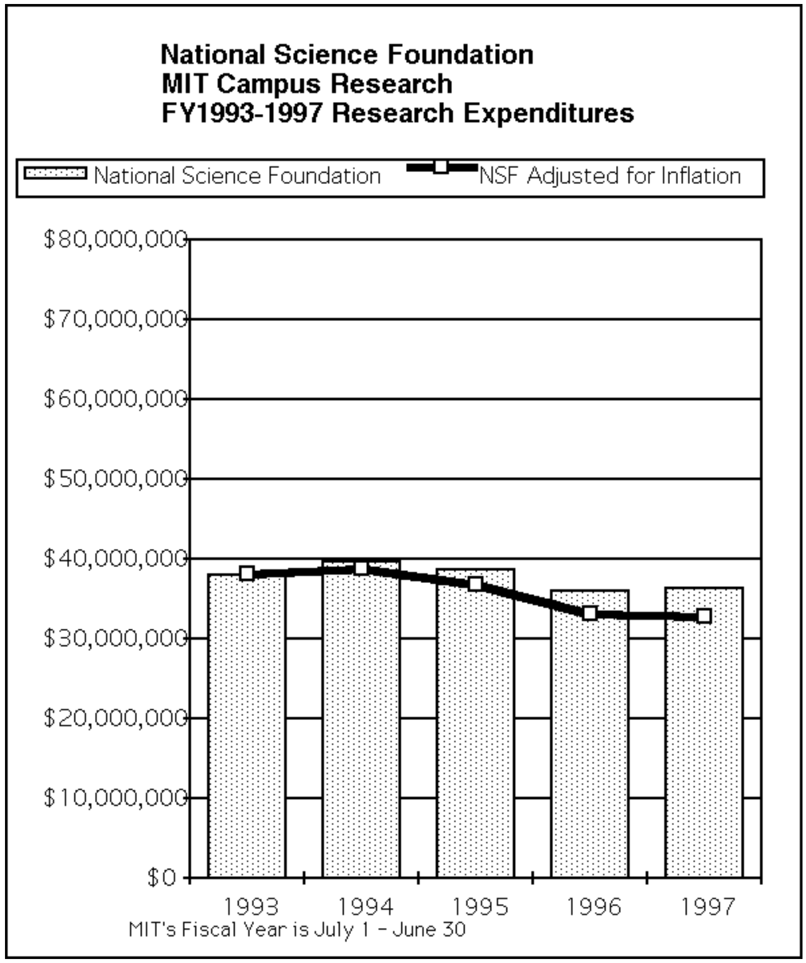
Language Structure

The Department of Linguistics and Philosophy and the Department of Brain and Cognitive Science have undertaken a joint project to give graduate students intensive research training in language structure, acquisition and use. Traditionally, the study of language acquisition at MIT has been pursued separately as part of linguistics and as part of cognitive science. This project is funded by an NSF grant designed for programs that train students in rapidly advancing areas that transcend a single academic discipline.

Violent Beginnings for Some Planets

The dozen or so new planets discovered within the past year probably had violent beginnings, mainly because they were born in solar systems with two or more massive planets the size of Jupiter, according to MIT astrophysicists. The properties of the new planets, which are completely different from those in our solar system, may be the result of instabilities that developed when they formed. These instabilities were caused by the planets' close proximity to one or more Jupiter-sized planets in their planetary systems. Supercomputer simulations for the research were done by the MIT scientists at the Cornell Theory Center, which receives major funding from the NSF and New York State.

National Science Foundation



The National Science Foundation funding in FY97 was $36.3 million.

Leading Departments, Centers and Laboratories Receiving National Science Foundation Support (FY1996 figures)
Department of Earth, Atmospheric & Planetary Science
Center for Materials Science and Engineering
Chemistry Department
Biotechnology Process Engineering Center
Francis Bitter Magnet Laboratory

Other Funding
NSF Fellows: These distinguished graduate students may enroll in any accredited, nonprofit U.S. or foreign institution offering advanced degrees in science or engineering. MIT is one of the top three institutions chosen by Fellows. For 1996–97 MIT had 262 NSF Fellows, 222 on active status and 40 on reserve status. Under this program, NSF provides $8,600 toward tuition for each active Fellow, a total of $1.86 million. MIT provides approximately $19,100 per year for each Fellow to cover tuition and health insurance, a total of $4.1 million. In addition, NSF provides each Fellow with a stipend of $14,400 for 12 months, a total of $3.1 million.

From Locating Stars to Emergency Calls

MIT scientists have developed equipment that allows a worldwide network of radio telescopes to record and process data faster. The synchronized telescopes allow the precise location and imaging of quasars and the monitoring of the movement of the Earth's tectonic plates.
The work was sponsored by the NSF and NASA. A recent spin-off of the technology allows the accurate location of 911 emergency calls from cellular phones. This system has been successfully tested at various locations in the northeastern U.S.

Understanding Solar Bursts

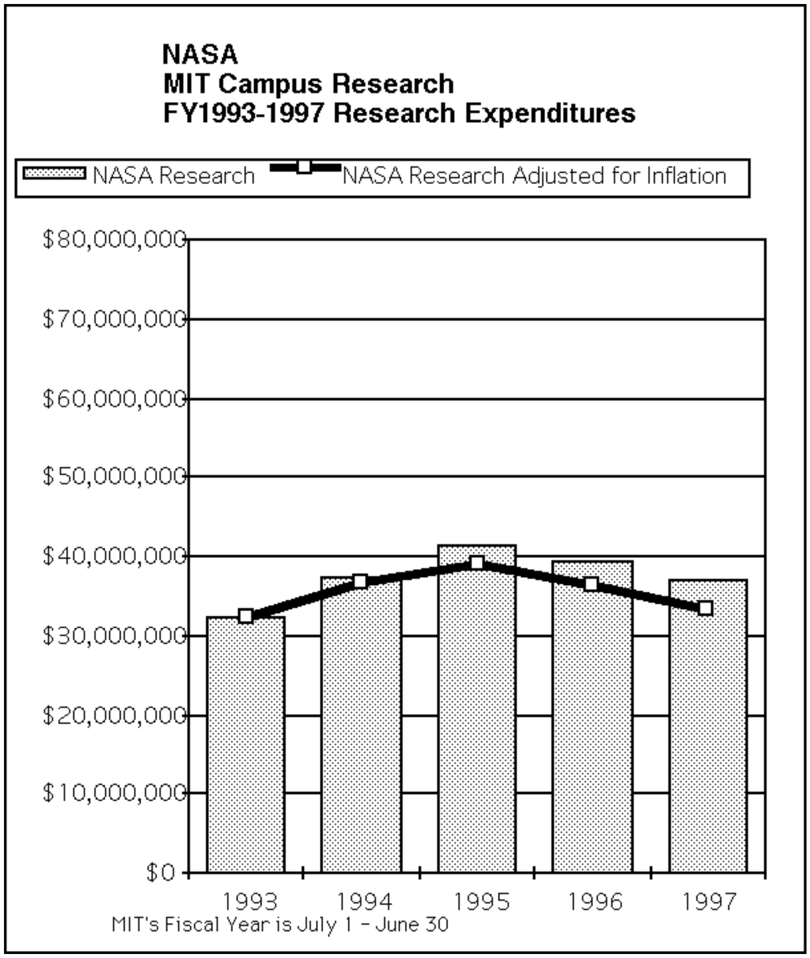
Two MIT instruments are helping scientists understand the impact of solar bursts from the Sun on the near-Earth space environment. The instruments, which are aboard the Wind satellite, for the first time have allowed scientists to verify whether particular solar clouds seen leaving the Sun actually arrive at Earth. The instruments eventually may help scientists predict "weather" caused by these clouds that can disrupt communications and/or damage satellite hardware.

X-Ray Astronomy Satellites

The Institute of Space and Astronomical Science of Japan is building a series of X-ray astronomy satellites. The Astro-E is scheduled to be launched in early 2000. MIT is now under contract with NASA for the development and testing of Charge Coupled Device focal plane assemblies and associated systems for the X-ray Imaging Spectrometer to be flown on this mission. The effort includes pre-flight software simulators and prototype hardware as well as ground support equipment.

Darts in Space

An MIT experiment that ran aboard the Russian space station *Mir* involved videotaping crew members playing darts to study how they adapt to zero gravity. In a second part of the experiment, the researchers collected data on how crew members physically affect their environment. That data could save millions in the design of future space structures. Currently there is very little data on the forces astronauts exert on spaceships, so engineers must over-design the racks housing sensitive experiments that could be disturbed by astronauts' movements.



The National Aeronautics and Space Administration funding for FY97 was $36.9 million.

Leading Departments, Centers and Laboratories Receiving NASA Support (FY1996 figures)

Center for Space Research
Aeronautics & Astronautics Department
Department of Earth, Atmospheric & Planetary Sciences
Haystack Observatory
Health, Science and Technology

Advanced Traveler Information Systems

ATIS uses the latest technology to provide accurate traffic information and navigation aid to travelers to avoid congestion, accidents, or road repairs. In this project, sponsored by the Department of Transportation, researchers are analyzing the behavior of travelers in acquiring and processing information, as well as their adjustments to daily and en-route travel choices.

Cleaning Up Groundwater Pollutants

In work that could lead to better ways of cleaning up certain pollutants from groundwater, MIT researchers are looking at the interactions between those pollutants and the soils and water they move through. Groundwater contaminants like carbon tetrachloride that are in the form of nonaqueous phase liquids (NAPLs) are extremely challenging to clean up, because the behavior of NAPLs in the subsurface is very complex. The researchers are exploring that behavior via several different projects. The work is sponsored by the EPA's Northeast Hazardous Substance Research Center.

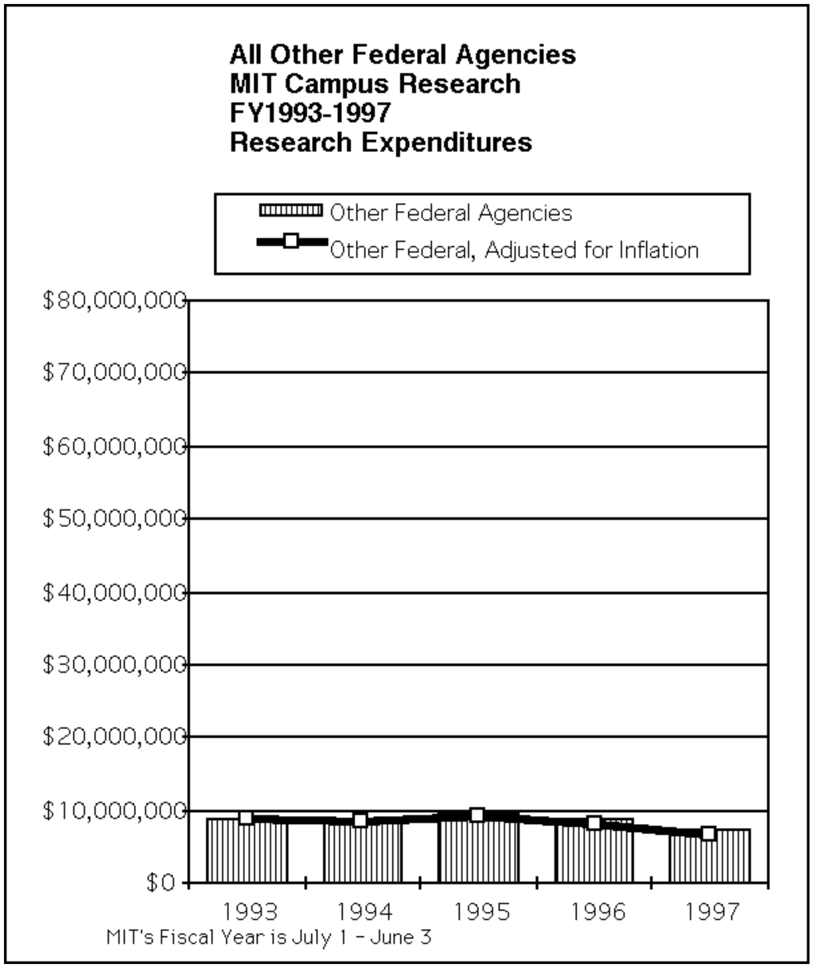
Deep-Sea Biodiversity

Changes in climate affect the biodiversity of even the deepest-dwelling animal communities in the ocean, according to an MIT scientist and colleague. The research counters the long-held hypothesis that deep-sea life — three kilometers or more beneath the surface of the ocean — is insulated and relatively impervious to large-scale climatic changes at the water's surface. The research was funded by the U.S. Geodetic Survey and the American Chemical Society.

A New Corn-Plastic Material

Plastic is popular because it is flexible, waterproof and inexpensive, but it is not biodegradable. An MIT professor has developed a more environment-friendly material combining corn starch and poly(ethylene vinyl alcohol) or EVOH. However, this material can become soft or brittle with changing atmospheric conditions. Consequently, the scientist has focused on creating a thin surface coating with the protective properties of pure plastic. Once the product is discarded and shredded, the biodegradable interior will be exposed to the elements. The research is funded by the U.S. Department of Agriculture, Warner Lambert, the National Association of Wheat Growers and NSF.

Other Federal Agencies



The funding from other federal agencies in FY97 was $7.2 million.

Leading Departments, Centers and Laboratories Receiving Other Federal Agency Support (FY1996 figures)
Sea Grant College
Center for Transportation Studies
Energy Laboratory
Microsystems Technology Laboratory
Department of Earth, Atmospheric and Planetary Sciences

Other Funding
The Arts: MIT's List Visual Arts Center received $35,500 from the National Endowment for the Arts in Fiscal Year 1996 to support exhibition funding.

Solving Transportation Problems Using Genetic Algorithms

With a grant from the UPS Foundation, the charitable arm of United Postal Service, MIT researchers are looking for improved techniques for determining the best transportation route for package delivery services. They are using genetic algorithms (GAs) to aid in the search for optimal or nearly optimal solutions. Genetic algorithms are a general-purpose approach for solving problems that rely on ideas from evolutionary biology.

Productivity Enhancement

The overhead involved in managing and integrating relevant pieces of information in information systems has become a major barrier to enhancing productivity. To attack the problem, researchers have established an initiative, called Productivity from Information Technology (PROFIT), which seeks to enhance productivity in private and public sector areas ranging from finance to transportation, manufacturing, and telecommunications. The research is supported by funds from Defense Advanced Research Projects Agency (DARPA), Ishikawajima-Harima Heavy Industries Co., and other sponsors.

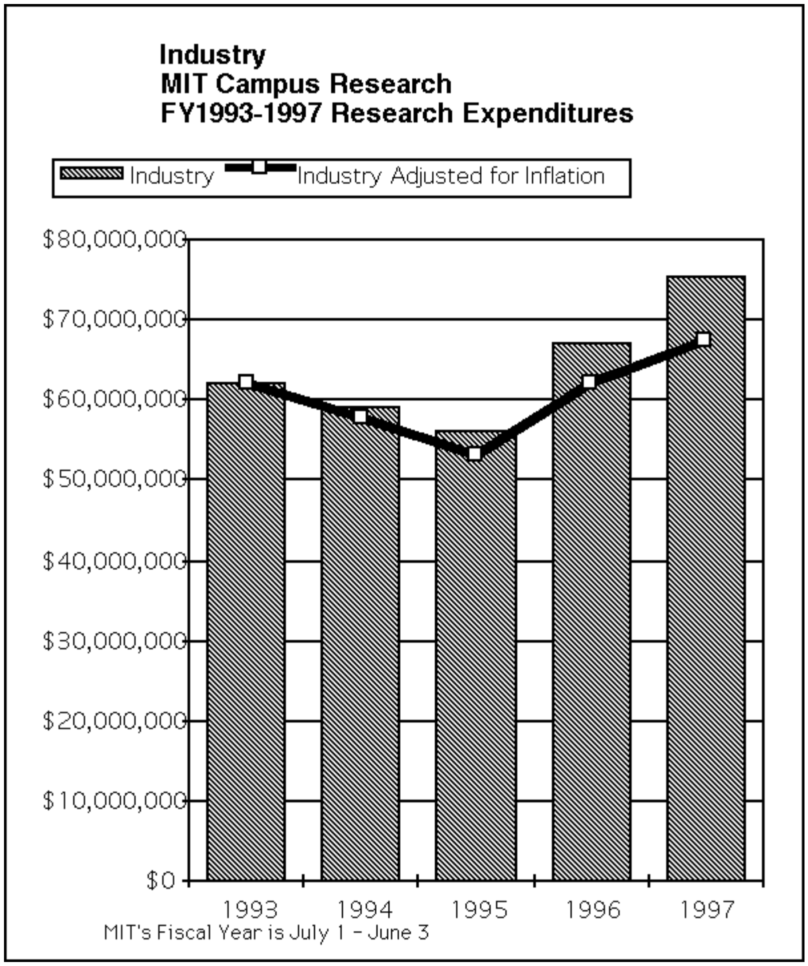
High-Performance SMP Computing

The recent donation of nine Sun Microsystems Ultra Enterprise 5000 symmetric multiprocessor servers (SMPs) to MIT will enable collaborative work with corporate and government partners in developing software and hardware for scalable clusters of SMPs, which MIT researchers believe provide the most promising path to affordable high-performance computing. Applications by the MIT scientists include establishing fundamental understanding of the properties, behavior, and aging of materials, and determining the long-term behavior of the ocean and its impact on Earth’s climate.

Printing Drugs

Using a three-dimensional printing device similar to a computer ink-jet printer, MIT scientists are “printing” drugs into pills, creating highly precise doses they say will be more effective and have fewer adverse side effects. Two MIT professors developed 3-D printing eight years ago to produce solid parts with intricate architectures. It originally was used to make ceramic molds for investment-cast car and airplane components. The drug-printing work is sponsored by Therics, Inc.

Industry



The funding from industry in FY97 was $75.2 million.

Leading Departments, Centers and Laboratories Receiving Industry Support (FY1996 figures)

Media Laboratory
Energy Laboratory
Laboratory for Computer Science
Center for Transportation Studies
Mechanical Engineering Department
Chemical Engineering Department
Lab for Manufacturing and Productivity
Organizational Learning Center
Whitaker College
Microsystems Technology Laboratory

MIT Lincoln Laboratory at Hanscom Air Force Base

Research Support

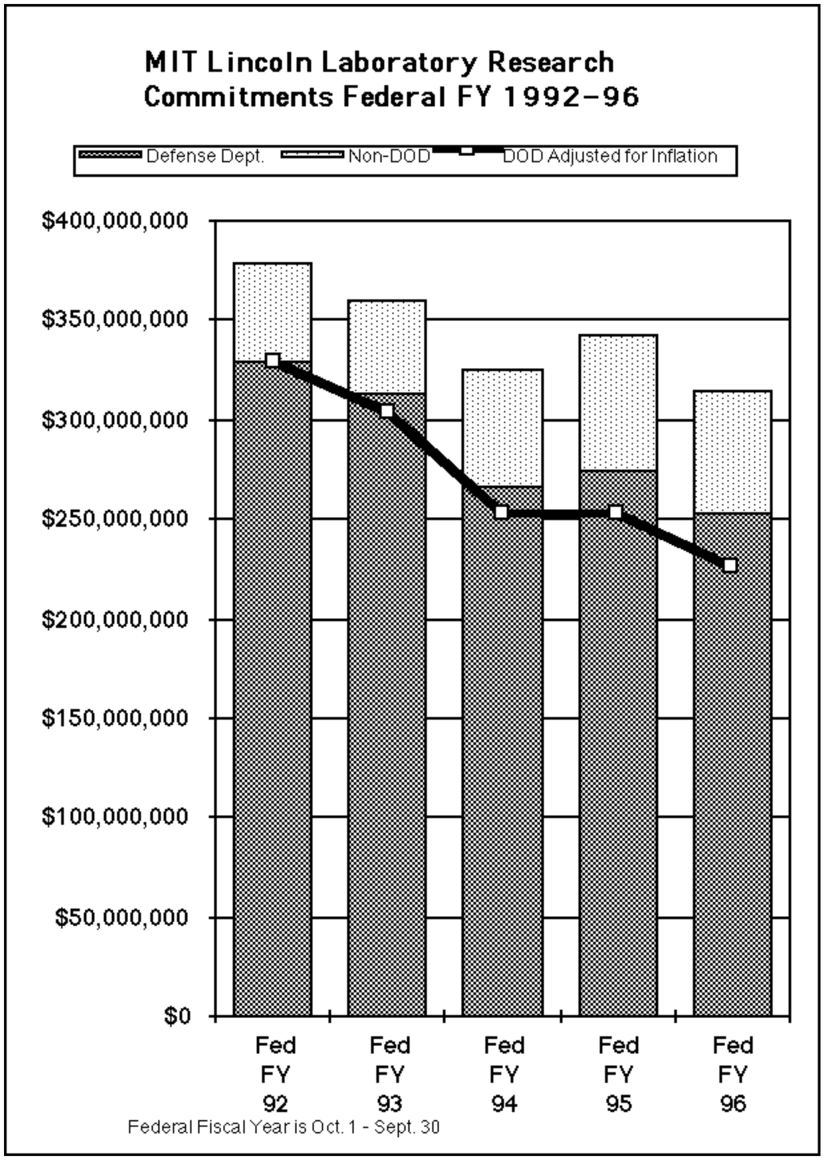
MIT Lincoln Laboratory is a federally-funded research and development center (FFRDC) operated on Hanscom Air Force Base in Lexington, Mass. by MIT under a contract with the Department of Defense. MIT established the laboratory in 1951 after Air Force Chief of Staff Gen. Hoyt S. Vandenberg wrote MIT President James R. Killian, Jr. that MIT was "almost uniquely qualified" to conduct the air defense work needed. Dr. Killian said MIT would agree to do it "on a no-gain, no-loss basis."

In defense work, Lincoln Laboratory is noted for its developments of the SAGE air defense systems and the Distant Early Warning (DEW) Line of surveillance radars in the 1950s. In more recent times, the Laboratory has developed satellite communication technology, advances in air defense, surveillance radars, missile defense, air traffic control systems, environmental sensing and a wide variety of contributions in the area of advanced electronics technology.

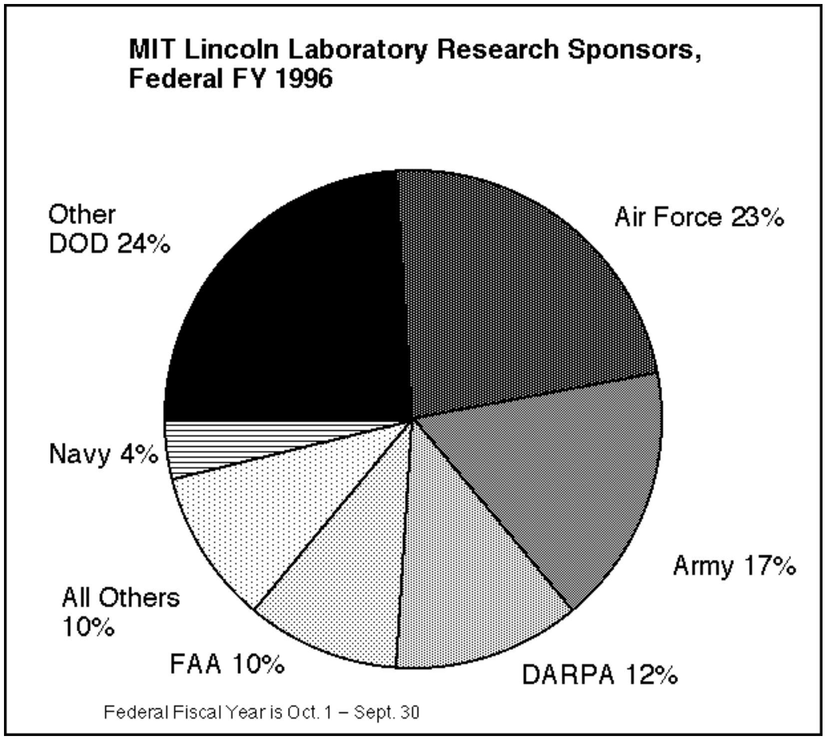
Lincoln Laboratory has created thousands of spin-off jobs in the civilian sector. Former lab engineers and scientists, and patented technology from the lab, have created more than 67 companies and over 130,000 jobs across the nation.

The Defense Department's projects for the Army, Navy, Air Force, the Defense Advanced Research Projects Agency (DARPA) and the Ballistic Missile Defense Organization (BMDO) as well as other federal agencies (principally the Federal Aviation Administration (FAA), National Oceanographic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA)) are channeled through Lincoln Laboratory's contract with the Air Force. Defense Department projects accounted for 80% of Lincoln Laboratory funding in FY96 (Federal). The Office of the Secretary of Defense also provides through the Director of Defense Research and Engineering sustained funding for the development of advanced electronic technology. DOD funding had been decreased from a FY90 peak of $385 million to a FY96 funding ceiling restrained level of $252.3 million. In FY97, the DOD funding ceiling has been increased to $258 million with additional funding for equipment purchases permitted. Funding has increased for non-DOD programs including the recently permitted mechanism for the cooperative research and development agreement (CRDA) with industry. Lincoln Laboratory has had 26 CRDAs approved to date. Employment at Lincoln Laboratory has decreased from a peak of almost 2,900 to approximately 2,050 today. The technical professional staff is approximately 1,000 with 40% holding PhDs.

Trend



The Department of Defense funding for Lincoln Laboratory in Federal FY96 was $252 million and is projected to be $258 million plus additional funding for equipment purchases in Federal FY97. The total funding for Lincoln Laboratory in Federal FY96 was $318 million, down from $352 million in Federal FY95.



Recent Projects

Lincoln Laboratory continues as a premier national research and development facility to carry out work in broad mission areas of ballistic missile defense, communications, space surveillance, tactical surveillance, air defense, civilian air traffic control and environmental sensing, all of which are supported by an advanced electronic technology program. While Lincoln Laboratory is a classified facility and works on classified programs, the majority of the work is unclassified. Recent unclassified activities include:

Microelectronics Facility

Lincoln Laboratory's new microelectronics facility is designed to permit fabrication of advanced semiconductor devices and develop a future state-of-the-art semiconductor process for U.S. industry. This facility has 8,100 square feet of Class 10 clean rooms and houses the newly developed excimer-laser lithographic stepper which is being used with industry for development of very high-density semiconductor wafer fabrication. Processes are being developed to improve the semiconductor industry's capability to produce semiconductor features that are smaller than 0.25 microns. Semitech and semiconductor companies are working cooperatively with Lincoln Laboratory on lithography and photo-resist technology.

Semiconductor silicon charge coupled devices are being developed in the microelectronics facility for low light-level imaging cameras. Focal plane arrays of 5 million pixels on a single wafer are being fabricated in the facility with existing technology.

Wideband All-Optical Network

In the communications area, researchers are working to enhance the capabilities of military communications through the design of future lightweight, high-performance, interference-resistant satellites and small mobile terminals. In addition, optical communication technology is also being pursued. A DARPA-sponsored consortium of MIT, MIT Lincoln Laboratory, American Telephone and Telegraph and Digital Equipment Corporation is working to establish an all-optical network. A wideband optical link between the Laboratory and the Campus has been established and a test bed is being developed to demonstrate the capability of the equipment developed.

High-Resolution SAR for Critical Target Identification

Surveillance and detection of critical targets is a major activity of Lincoln Laboratory. The need to detect and classify military targets is of increasing interest because the need for precision strikes in limited warfare is an important part of our defense posture. Lincoln Laboratory has developed high-resolution synthetic-aperture radar (SAR) imagery to aid automatic target recognition and is developing algorithms for field testing for correct classification. Neural networks are also being explored for these applications.

Improved Air-Traffic Control

Lincoln Laboratory has played a major role in developing new technology for air-traffic control. FAA has sponsored the improvement of terminal radars, hazardous weather detection and collision avoidance systems at the Laboratory. Lincoln Laboratory built the first Mode S sensor and also built and flew the first TCAS collision avoidance system being installed on all air carrier aircraft. Current activity includes Airport Surface Traffic Automation to aid controllers and pilots in preventing errors that lead to runway incursions and accidents, and also to reduce surface delays. Additionally, the laboratory has demonstrated a radar system to improve monitoring of aircraft during final approach, thus allowing independent approaches.

Utilization of the Global Positioning System (GPS) to allow aircraft to provide position information in their Mode S spontaneous periodic broadcast (squitter) has been successfully demonstrated. This GPS squitter technology offers significant advantage in the merging of automatic dependent surveillance and the Mode S beacon system.

Weather Guidance for Pilots

Researchers are developing the Graphic Weather Service, a system to deliver real-time weather images to the cockpits of commercial and private aircraft. The system digitizes and compresses weather images and transmits them via radio data link. The cockpit display would include weather radar, lightning, turbulence, icing, and wind shear.

Lincoln Laboratory has also been testing air terminal weather information systems. Terminal Doppler Weather Radar systems have been tested in Denver, Kansas City, Orlando, and Dallas, and Airport Surveillance Radar systems have been tested in Huntsville, Kansas City, Orlando and Albuquerque. This work is leading to a fully Integrated Terminal Weather System (ITWS). Demonstration ITWS systems being tested in Orlando, Memphis and Dallas are generating information used in real-time to provide critical weather information to air-traffic controller managers, to pilots and to airliners. The system will provide benefits to improved terminal operations in the presence of adverse weather.

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MIT and Industry

Since its charter, MIT has had a tradition of working closely with industry. Industry has long provided philanthropic support for the educational mission at MIT, including gifts that have established professorships, undergraduate scholarships and graduate fellowships. The exchange of people and ideas between the Institute and the business community has inspired curricular innovations in a range of disciplines. These innovations have in turn helped generations of MIT graduates make major contributions in industry, government and academia; have led to a stream of research advances; and have enabled a large number of beneficial products to come to the marketplace.

Key Elements

Key elements of what MIT provides to industry include:

Sponsored Research
Industry sponsors more research at MIT than at any other university. Some 400 industrial organizations supported about $75 million worth of research last year. In many instances, companies join together in consortia to support research on campus.

Entrepreneurship
MIT graduates, faculty and staff have founded 4,000 firms which, in 1994 alone, employed at least 1.1 million people and generated $232 billion of world sales. MIT-related jobs are in every state of the nation, with 160,000 to 10,000 jobs in these states: California (160,000), Massachusetts, Texas, New Jersey, Pennsylvania, Ohio, Colorado, Florida, Virginia, New York, Georgia, Kansas, Iowa, Illinois, Wisconsin, Washington, Connecticut and Oregon (10,000). See below for summary, Page 5-2.

Licensing Inventions
The Institute typically receives over 100 patents a year, more than any other single U.S. university. MIT's Technology Licensing Office works with industry in arranging for these inventions to be licensed and introduced into the marketplace. Since 1987 MIT has granted over 500 licenses, and helped spin off scores of companies.

MIT Commission on Industrial Productivity
In 1989, this commission produced a highly acclaimed book, *Made in America: Regaining the Productive Edge.* This report was the result of a two-year study of the nation's decline in industrial production, by 16 senior faculty. This widely cited analysis also spawned three additional country studies in Sweden, France and Japan with results released in September, 1993.

Leaders for Manufacturing Program
This program, started in 1988, is an innovative educational/research partnership of MIT with fifteen leading U.S. manufacturing companies to help the U.S. compete more effectively in a global marketplace. Its goals are to discover and codify guiding principles for world-class manufacturing,

educate future leaders for manufacturing firms, and improve manufacturing education, research, and practice through an active industrial-academic collaboration. Through the program, students earn a masters in both management and in engineering while they serve an internship on the manufacturing floor of one of the industry sponsors.

The companies principally involved in this program are:
AlliedSignal Corporation
Aluminum Company of America
The Boeing Company
Chrysler Corporation
Digital Equipment Corporation
Eastman Kodak Company
Ford Motor Company
General Motors Corporation
Hewlett-Packard Company
Inland Steel Industries
Intel Corporation
Motorola, Inc.
Polaroid Corporation
Tenneco Corporation
United Technologies Corporation

MIT Industrial Performance Center

The MIT Industrial Performance Center is dedicated to the interdisciplinary study of industrial performance in the U.S. and other advanced economies. With the participation of faculty and students from all five schools of MIT, the Center today serves as a listening post on industry, monitoring patterns of organizational and technological best practice. Center researchers are conducting research in four areas: technology and the American worker; new organizational strategies for R&D, design and product development; globalization; and performance measurement. The Center is also conducting the “Made By Hong Kong” project on the future of Hong Kong industry.

Industrial Liaison Program

Established in 1948, the ILP enables its more than 200 member companies to draw on MIT’s expertise to help solve problems. The companies, in turn, help faculty members stay abreast of developments in industry. The program fosters company involvement in MIT’s research and educational activities.

MIT Japan Program

The MIT Japan program was established in 1981 to create the first generation of American scientists, engineers and managers who can speak Japanese and work as professionals in their respective fields in Japan. The program is sponsored by a consortium of sixteen U.S.-based multinational corporations, foundations, and the U.S. government. The program reaches out to industry through its bi-monthly MIT Japan Science and Technology Newsletter, conferences, satellite broadcasts, and working papers on topics related to Japan industry, technology, and public policy.

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Student Financial Aid

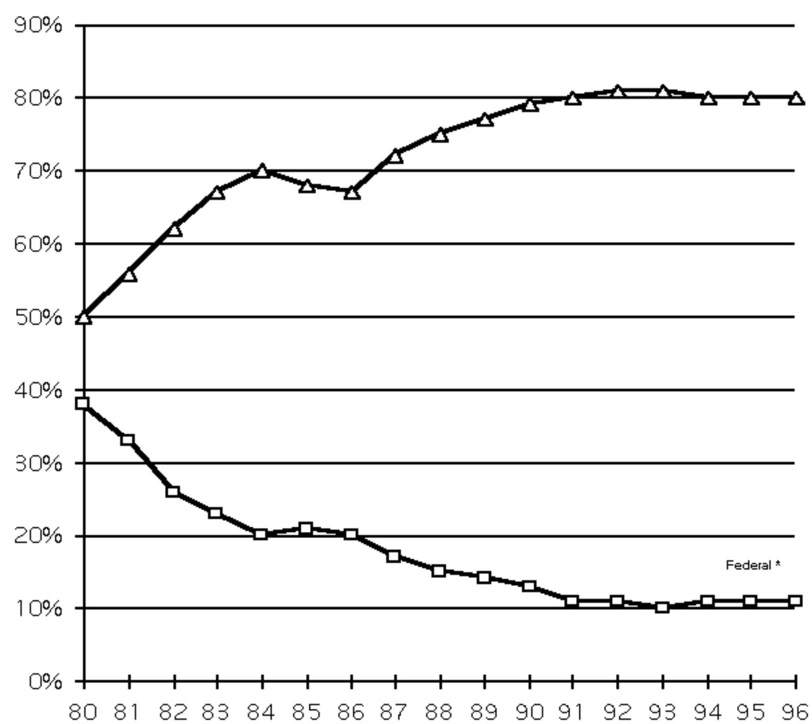
MIT's undergraduate financial aid program is based on the understanding that the best way to assure access for qualified students and to maintain diversity within the student community is to provide financial aid on the basis of demonstrated need. Equally important, MIT is committed to meeting the full need for every undergraduate, joining with the families, the students, outside contributors, and the federal government to meet educational costs.

MIT more closely resembles the American population today than it did twenty years ago, and this is directly attributable to the access which the financial aid program has provided. In MIT's need-blind policy of admissions, students are accepted to the school on the basis of merit and students who come here have all of their financial need met.

Aid comes under three general categories: grants, loans and work/study. MIT, the federal government, and other outside scholarship sources share in providing this aid to students. MIT provides the largest proportion, over 80%, of the grants.

Funding of Grants 1980-1996

Percent of Total Need-based Grants Funded by Federal and MIT Sources
*Federal includes Pell, SEOG, ROTC.
In FY94 the government allowed universities to convert a larger portion of federal loan and work study funds into grants, without increasing overall allocations.

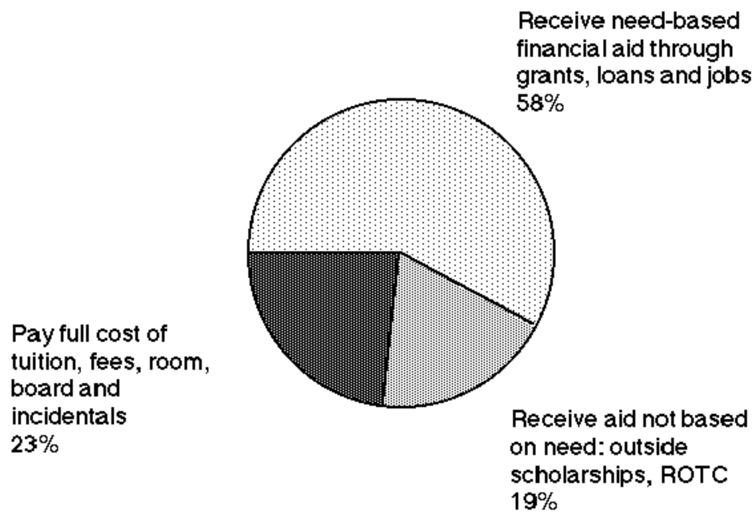


Tuition and Fees — Undergraduate

1997–98 Academic Year
Tuition—$23,100
Room & board—$6,550

1996–97 Academic Year
Tuition—$22,000
Room & board—$6,350

Meeting the Costs of Education
MIT undergraduates, 1996–1997



Average aid for a needy student in 1996–97 was $20,732, up 3.1% from the previous year. Total aid was $59 million.

Tuition for the past two decades has covered only half the cost of an MIT education. The balance is paid by MIT from its gifts, income from endowment, and other income.

Of the 58% of MIT students who received aid, four out of five received over $13,500 in student aid per year.

Types of Aid

Following are the types of financial aid offered to students at MIT:

Grants

Pell Grant
A federal grant program whereby needy students may receive up to $2,700 in 1997–98.

Supplemental Educational Opportunity Grant
A federal grant program that provides up to $4,000 per year. MIT receives a federal allocation of funds which the Institute awards first to the lowest income families and moves up the scale until the allocation has been exhausted.

MIT Grant
A scholarship awarded on the basis of need and drawn from MIT's scholarship endowment and unrestricted funds.

MIT Opportunity Awards
An MIT grant program for families with very low income. This grant replaces a portion of the amount that the student has been asked to borrow or earn.

Federal Work/Study Program

In this program, students apply for and work in on-campus jobs and receive wages which are federally assisted.

Loans

Perkins Loan
A federal loan with MIT matching funds, based on financial need, awarded to students who are US citizens or permanent residents, with MIT acting as lender.

Federal Direct Student Loan
A federal loan, based on financial need, awarded to students who are US citizens or permanent residents. MIT determines student eligibility, but the lender is a participating bank. The federal government backs the loans.

MIT Technology Loan
An MIT loan, based on financial need, that may be used to replace federal work/study or job eligibility.

Parental Loans
A number of loans are available to parents to help pay the resources expected from family income and assets. These loans, including federal Parent Loan for Undergraduate Students (PLUS), are available at most income levels and usually require the applicant to be "credit-worthy."

Sources of Financial Aid
Undergraduate Students
September 1995–May 1996†

Type of Aid	Amount	Students In This Category Of Aid *
MIT Need-Based Aid:		
MIT Grants	$27,474,000	2,310
MIT Loan	2,061,000	429
Perkins Loan	441,000	2,130
Work/Study Wages Funded	235,000	1,139
MIT Need-Based Aid	**$30,211,000**	***2,669**
MIT Aid Not Based on Need		
Wages, Student Jobs	$5,283,000	2,982
Loans to Parents	1,485,000	108
MIT Aid Not Based on Need	**$6,768,000**	***3,017**
Total MIT Aid	**$36,979,000**	***3,622**
Federal Need-Based Aid:		
Stafford Loan (subsidized)	$9,444,000	2,392
Perkins Loan	3,970,000	2,130
Supplemental Educational Opportunity Grant	1,970,000	512
Pell Grant	1,183,000	733
Work/Study Wages Funded	705,000	1,139
Federal Need-Based Aid	**$17,272,000**	***2,547**
Federal Aid Not Based on Need		
ROTC (Reserve Officers Training Corps) Grants	$2,182,000	103
PLUS Parent Loans	2,377,000	221
National Science Scholar Grants	209,000	224
R.C. Byrd Scholarships	522,000	350
Federal Aid Not Based on Need	**$5,290,000**	***est. 400**
Total Federal Aid	**$22,562,000**	**est. 2,815**
TOTAL MIT AND FEDERAL AID	**$59,541,000**	***4,051**

*Students get multiple forms of aid, so categories can't be added.
†Figures for 1996–97 are not available at the date of printing.

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Current Federal Issues

For this section, briefs on selected federal policy and other issues of current interest will be provided.

MIT: The Impact of Innovation

A Special Report of the BankBoston Economics Department

MIT Graduates Have Started 4,000 Companies With 1.1 Million Jobs, $232 Billion in Sales in 1994

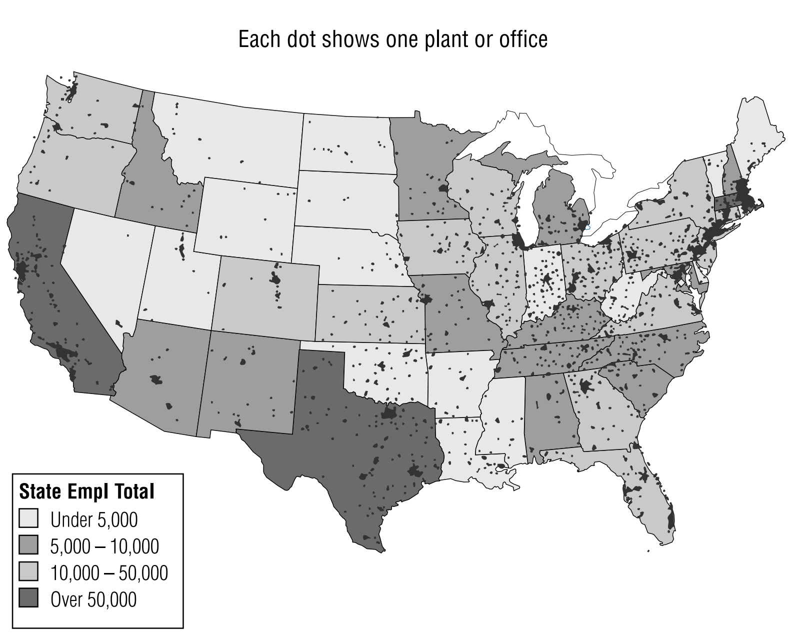
In the first national study of the economic impact of a research university, the BankBoston Economics Department reports that graduates of the Massachusetts Institute of Technology have founded 4,000 firms which, in 1994 alone, employed at least 1.1 million people and generated $232 billion of world sales.

The report “represents a case study of the significant effect that research universities have on the economies of the nation and its 50 states.”

Wayne M. Ayers, chief economist of BankBoston, said, “MIT is not the only university that has had a national impact of this kind, but because of its historical and continuing importance, it illustrates the contribution of research universities to the evolving national economy.”

MIT President Charles M. Vest, commenting on the report, said, “About 90 percent of these companies have been founded in the past 50 years, in the period of the great research partnership between the federal government and the research universities. The development of these business enterprises is one of the many beneficial spinoffs of federally funded research, which has brought great advances in such fields as health care, computing and communications.”

EMPLOYMENT AT ALL PLANTS OF MIT-RELATED COMPANIES



The companies employed a total of 733,000 people in 1994 at more than 8,500 U.S. plants and offices in the 50 states — equal to one out of every 170 jobs in America.

• Eighty percent of the jobs in the MIT-related firms are in manufacturing (compared to 16 percent nationally), and a high percentage of products are exported.

• The MIT-related companies, if they formed a nation, would rank as the 24th largest world economy in 1994 because the $232 billion in world sales “is roughly equal to a gross domestic product of $116 billion, which was a little less than the GDP of South Africa and more than the GDP of Thailand.”

• The five states benefiting most from MIT-related jobs are California (162,000), Massachusetts (125,000), Texas (84,000), New Jersey (34,000) and Pennsylvania (21,000).

Thirteen other states have more than 10,000 MIT-related jobs — from west to east, Washington, Oregon, Colorado, Kansas, Iowa, Wisconsin, Illinois, Ohio, Virginia, Georgia, Florida, New York and Connecticut. Another 25 states have 9,000 to 1,000 jobs from MIT-related companies. Only seven low-population states and the District of Columbia had less than 1,000 jobs from MIT-related companies.

• The study also looked at employment around the nation and the world from MIT-related companies. Massachusetts firms related to MIT had 353,000 worldwide jobs; California firms had 348,000 world jobs.

• Other major world employers included firms in Texas, 70,000; Missouri, 63,000; New Jersey, 48,000; Pennsylvania, 41,000; and New Hampshire, 35,000.

• In determining the location of a new business, the 1,300 entrepreneurs surveyed said the quality of life in their community, proximity to key markets and access to skilled professionals were the most important factors, followed by access to skilled labor, low business cost and access to MIT and other universities.

• More than 2,400 companies have headquarters outside the Northeast. The report noted, "MIT-related companies have a major presence in the San Francisco Bay area (Silicon Valley), southern California, the Washington-Baltimore-Philadelphia belt, the Pacific Northwest, the Chicago area, southern Florida, Dallas and Houston, and the industrial cities of Ohio, Michigan and Pennsylvania."

• The MIT-related companies "are not typical of the economy as a whole; they tend to be knowledge-based companies in software, manufacturing (electronics, biotech, instruments, machinery) or consulting (architects, business consultants, engineers). These companies have a disproportionate importance to their local economies because they usually sell to out-of-state and world markets, and because they so often represent advanced technologies." Other industries represented include manufacturing firms in chemicals, drugs, materials, aerospace; energy, publishing and finance.

• MIT graduates and faculty have been forming an average of 150 new firms a year since 1990.

• MIT graduates, in interviews, cited several factors at MIT which spurred them to take the risk of starting their own companies — faculty mentors, cutting-edge technologies, entrepreneurial spirit and ideas.

• In Massachusetts, the 1,065 MIT-related companies represent five percent of total state employment and ten percent of the state's economic base (sales in other states and the world). MIT-related firms account for about 25 percent of sales of all manufacturing firms and 33 percent of all software sales in the state.

• The companies include 220 companies based outside the United States, employing 28,000 people worldwide.

• Some of the earliest known MIT-related companies still active are Arthur D. Little, Inc. (1886), Stone and Webster (1889), Campbell Soup (1900) and Gillette (1901).

The report notes that many of the MIT-related founders also have degrees from other universities, and these entrepreneurs maintain close ties with MIT or other research universities and colleges. The report is the result of an MIT survey of 1,300 founders and two years of fact-gathering by MIT and BankBoston.

Companies Founded by MIT Graduates/Faculty Are in All 50 States

More than $1 Billion in Annual Sales in Each of 26 States
More than 5,000 Jobs in Each of 31 States

State	Jobs, MIT-Related	Sales, MIT-Related Plants & Offices (in millions)*
Alabama	9,300	$1,091
Alaska	360	$56
Arizona	7,600	$1,163
Arkansas	2,500	$493
California	162,000	$19,216
Colorado	15,600	$3,164
Connecticut	10,300	$890
District of Columbia	770	$88
Delaware	2,100	$306
Florida	15,500	$2,521
Georgia	14,800	$2,852
Hawaii	400	$79
Idaho	5,300	$1,133
Illinois	12,100	$1,899
Indiana	4,700	$489
Iowa	13,300	$960
Kansas	13,900	$526
Kentucky	5,600	$772
Louisiana	2,100	$562
Maine	2,100	$410
Maryland	6,800	$958
Massachusetts	125,000	$16,669
Michigan	7,600	$1,073
Minnesota	5,500	$2,445
Mississippi	1,030	$158

State	Jobs, MIT-Related	Sales, MIT-Related Plants & Offices (in millions)*
Missouri	9,200	$1,143
Montana	60	$18
North Carolina	8,100	$1,680
North Dakota	110	$64
Nebraska	1,900	$1,048
Nevada	1,300	$36
New Hampshire	8,800	$1,574
New Jersey	33,700	$1,834
New Mexico	5,300	$1,035
New York	15,100	$3,092
Ohio	18,300	$3,327
Oklahoma	4,800	$843
Oregon	10,200	$2,891
Pennsylvania	21,000	$2,360
Rhode Island	3,900	$308
South Carolina	9,200	$1,101
South Dakota	380	$56
Tennessee	6,600	$890
Texas	84,200	$13,001
Utah	4,200	$524
Vermont	650	$47
Virginia	15,300	$1,626
West Virginia	1,260	$128
Washington	10,300	$1,327
Wisconsin	12,000	$1,373
Wyoming	130	$19

**Does not include headquarters-related sales of most multi-state companies*

For the full report, including maps and tables, see the Web page at <http://web.mit.edu/newsoffice/founders>

Contact: MIT News Office, (617) 253-2700

Value, Quality and Cost at America's Research Universities

The Value of Advanced Education and Research

Research universities generate new or improved technologies and industries that fuel the engines of economic growth. Case in point: According to a recent study by the BankBoston Economics Department, MIT graduates have founded or co-founded 4,000 firms which, in 1994 alone, employed 1.1 million people and generated $232 billion of world sales. Within the United States, these companies employed a total of 733,000 people equal to one out of every 170 jobs in America. MIT is not unique in this respect: similar studies conducted at other research universities would also yield impressive results.

For individual graduates, college degrees offer a greater likelihood of significantly higher lifetime earnings. Between 1975 and 1995, the gap between incomes for college graduates and high-school graduates more than doubled in size. Today, college-educated Americans 25 years or older enjoy average annual incomes 57 percent higher than those holding only high-school diplomas. Advanced degrees add even more value: each additional year of college provides a future return in income of 11 to 13 percent.

Maintaining Quality in a Time of Expanding Knowledge and Growing Complexity

Scientific and technological knowledge base is growing at about 4 to 8 percent per year, with a doubling of the knowledge base every 12 to 15 years. This increase in the amount and complexity of new knowledge requires universities to invest in new courses, improved libraries and information technology (computers, networks, etc.), and more complex and sophisticated research equipment.

Quality and Productivity: Research universities strive to be optimally productive while maintaining high quality. New technologies and teaching practices such as distance and distributed learning can augment and enhance the educational process, but cannot replace direct contact with faculty as teachers, mentors, advisors and research supervisors. Thus, providing quality in an era of increasing complexity and specialization requires research universities to maintain a relatively high faculty-to-student ratio.

Talent costs money. To maintain quality and attract talented students, universities must compete aggressively for the very best faculty. In most sectors of the American economy, compensation for the most senior and most successful professionals has risen much faster than for the working population as a whole. The field of education is no different, although senior faculty still make less than their opposite numbers in business, industry, medicine, law and other professions.

What It Costs to Obtain a College Education

Americans overestimate what college students must pay to receive a high-quality education. In the fall of 1996, the average tuition and fees at public colleges and universities was just under $3,000. Over 60 percent of *all* colleges and universities in the United States charge tuition of $3,000 or less. Only 12 percent of U.S. undergraduates attend schools with annual tuition bills of $14,000 or more.

The number of college students nationwide who actually pay out $20,000 or more each year for college tuition is less than one-half of one percent of the total college student population.

Between 1980 and 1990 the average tuition at private universities rose at a rate averaging 4.5 percent per year, but was partially offset by substantial increases in need-based private financial aid. When this aid is factored into the rate of net tuition increases, the average rate of tuition increase between 1980 and 1990 falls to 0.6 percent annually. Since 1990, increases in financial aid have kept net tuition costs close to the rate of inflation.

Case in point: At MIT, only 1 out of 4 students pays the full amount of tuition, without relying on scholarships or loans of any kind. Half of MIT's undergraduates receive enough aid to cut their tuition bills by 50 percent or more.

Beyond Tuition: Endowment, Gifts and Federal Aid

At most private universities, tuition pays for only about half of the cost of education. The balance is made up by the universities from their endowment income and gifts. Items included in the cost of education include classroom instruction, libraries, computer resources, lab equipment and materials, academic advising, research supervision, athletics programs, student activities, medical and counseling services, campus and building maintenance. (Students are billed separately for room and board.)

Over the past two decades, the federal government has reduced the amount of constant-dollar scholarship aid it provides, shifting the burden to colleges and universities. In the 1978/9 academic year, the maximum federal Pell Grant covered, on average, 54 percent of tuition costs at private, four-year colleges. By 1995/6, it covered only 20 percent of tuition at such schools. This shift in the role of the federal government has meant that, for the past several years, one of the fastest growing elements in college and university budgets is the amount of money dedicated to financial aid. Congress has begun to address this problem, but the decline has had a considerable impact.

State contributions to higher education have declined. Between 1985 and 1997, the share of state budgets devoted to higher education declined from 14 percent to 12 percent, placing additional pressures on state universities to cover costs through tuition increases. (During the same period, the share of state spending devoted to Medicaid and correctional facilities rose from 14 to 19 percent.)

Managing Cost Factors

The biggest pressures on college and university budgets come from the need to provide competitive salaries for faculty, adequate financial aid for students, new information technology, and sophisticated research equipment and health insurance. In addition, federal regulations, especially changing policies regarding reimbursement of research costs and graduate student support, have put dramatic pressures on university budgets.

Administrative costs, as a share of college budgets nationwide, have increased only slightly in recent years, from 12.9 percent of total spending in 1980 to 13.7 percent in 1992. Research universities have worked to increase their endowments (and thus their investment income), have reduced the size of their academic and administrative staffs, have reduced operating costs by streamlining administrative procedures, by adopting aggressive energy conservation programs, and many other means. Institutions such as MIT have also begun working with business and industry to develop collaborative research and education agreements which have brought millions of additional dollars on campus to invest in research and teaching programs.

The savings achieved by these methods, however, have been more than offset by the real-dollar decline in public funding and by continuing increases in other cost factors. For the most part, universities must therefore reinvest their savings in meeting other obligations rather than in rolling back tuition. Still, recent statistics show that the nationwide average rate of annual tuition increase is moderating.