Department of Mechanical Engineering

Mechanical engineering, one of the six founding courses of study at MIT, embodies the motto *mens et manus*—mind and hand. Disciplinary depth and breadth, together with hands-on discovery and physical realization, characterize the Department of Mechanical Engineering's nationally and internationally recognized leadership in research, education, and innovation. MIT-educated mechanical engineers have always stood at the forefront in tackling the engineering challenges of the day: inventing new technologies, spawning new fields of study, and educating generations of leaders in industry, government, and academia.

Today, mechanical engineering is one of the broadest and most versatile of the engineering professions. This is reflected in the broad portfolio of current research and education activities in the department, one that has widened rapidly in the past decade. Our faculty and students are involved in projects that aim to bring engineering solutions to a spectrum of global challenges, including:

- Clean and renewable energy technologies, including photovoltaics, wind energy, fuel cells, batteries, and carbon sequestration
- New thermal and membrane technologies for water purification and desalination
- Instrumentation, controls, and technologies for medical therapies and biomedical exploration
- Vehicles, acoustics, and control systems for underwater exploration and environmental monitoring
- Structure, materials, and advanced technologies for better protection of our first responders and soldiers
- Design, manufacture, and control of precision devices, machines, vehicles, processes, and robotics

These projects cover topics from fundamental engineering underpinnings to design, manufacturing, and fabrication of new structures, devices, and technologies. To meet these challenges, research in the department is broadly coordinated across seven areas:

- Mechanics: modeling, experimentation, and computation
- Controls, instrumentation, and robotics
- Design, manufacturing, and product development
- Energy sciences and engineering
- Ocean sciences and engineering
- Bioengineering
- Micro- and nanoengineering

Our three undergraduate degrees prepare students for professional practice in a world of rapidly advancing technology. A rigorous base in the engineering sciences is combined with hands-on laboratory experience. Product design classes encourage novel

inventions complete with competitive business plans. A new course featuring micro- and nanotechnologies provides undergraduates an opportunity to build, observe, and manipulate objects at the micro- and nanoscales. Our accredited flexible engineering degree enables students to tailor their engineering course selection around a self-selected specialty or a multidisciplinary field.

Our undergraduate and graduate education and research programs strive to define and to produce next-generation technologies and tomorrow's leaders. The department's mission is to be a leader in education and research, defining mechanical engineering for today and tomorrow. We seek to produce future leaders for industry, academia, government, and society—leaders whose vision is founded on fundamental knowledge, analytical skills, creativity, perspective, and ethics. We seek to advance technology and science by combining basic knowledge with the innovative application of engineering and scientific principles. And we seek to enrich our educational and research programs, and ultimately society, through service.

Our educational mission is to prepare students for careers involving technological innovation and leadership. Our undergraduate educational program provides a broad base on which successful careers in engineering and a number of other fields can be founded; the graduate program aims to prepare specialists, professionals, and scholars in mechanical engineering. The research mission of the department—which is to create knowledge, technologies, and ideas through fundamental research and the application of that research—is closely intertwined with its educational mission. Our graduates go on to a vast array of careers in product design, research, management, medicine, government, teaching, public service, and entrepreneurship.

This has been a good year for the Mechanical Engineering Department, one marked by many additions, changes, promotions, and honors. Our students and faculty have continued to be recognized for their originality and impact on research, education, innovation, and leadership in the field of mechanical engineering. Our research and education programs continue to innovate and to lead the field. Below, we provide an update on faculty hiring and promotions, followed by an overview of each of our seven disciplinary areas, an update on space renovations, updates on a sampling of our educational programs, and updates on recent faculty recognitions.

New Faculty Appointments and Promotions

We are very pleased to welcome three new faculty members to the department. Domitilla Del Vecchio received her PhD from the California Institute of Technology in 2005. Before joining MIT, she was an assistant professor at the University of Michigan, Ann Arbor. Domitilla's research focuses on control of nonlinear systems. Her research has two main thrusts: one in control of multivehicle systems and one in modular control versus retroactivity of the biomolecular networks of genes and proteins in living cells. She has demonstrated expertise in multidisciplinary dynamical system modeling; the ability to realize her research results in physical form; the ability to synthesize new methodologies; and a demonstrated ability to work productively across broad multidisciplinary areas. Domitilla received a National Science Foundation (NSF) Career Award in 2007 and the Donald P. Eckman Award from the American Automatic Control Council in 2010.

Pedro Reis received his PhD from the University of Manchester (United Kingdom) in 2004. He was a postdoctoral associate at the City College of New York (January 2004–September 2005) and then at Centre National de la Recherche Scientifique (France) from October 2005 to June 2007. He joined the MIT Department of Mathematics in June 2007 as an instructor and the Departments of Mechanical Engineering, and Civil and Environmental Engineering, as an assistant professor in July 2010. He has a broad training in physics and applied mathematics, with an emphasis on structural mechanics, fracture mechanics, dynamics, and experimental methods. His work addresses the interplay between the elasticity of thin structures, adhesion, and fracture mechanics. Pedro Reis combines an excellent understanding of the fundamentals of mechanics with deep physical insight. As an instructor in mathematics, he has shown innovation and leadership in teaching, where he has innovatively incorporated oral and written communications into the core undergraduate physical mathematics curriculum.

Commander Peter Small is joining the Mechanical Engineering Department for a two-year appointment as associate professor of the practice of naval construction and engineering. Professor Small, who received an NE degree from MIT in 2005, has extensive experience in naval ship systems. He served as the US Navy deputy ship design manager, Ohio-class Replacement Submarine–Naval Sea Systems. He is an expert in designing, building, overhauling, and operating submarines. He has extensive experience in naval architecture and systems engineering. His work runs the full spectrum of naval construction and engineering activities, including shipbuilding, repair, and maintenance of the existing fleet, and early-stage concept design for the next generation of submarines.

In January 2011, we will be pleased to welcome three additional faculty hires:

- Kostya Turitsyn in the field of nonlinear dynamics
- Nicholas Fang in the area of micro- and nanoengineering, with an emphasis on meta-materials
- Kenneth Kamrin in the field of solid mechanics

More complete biographies will be provided in next year's report. These appointments are consistent with our strategic plan of hiring faculty members who simultaneously strengthen our mechanical engineering core and extend our research activities into new areas. We anticipate three additional faculty searches in the upcoming academic year.

In the 2009–2010 academic year, we were pleased to announce the promotions of professor Thomas Peacock and professor Alexandra Techet from the rank of associate professor without tenure to the rank of associate professor with tenure. Each adds a unique signature to the department and to the Institute in terms of their individual achievements and contributions to research, education, mentorship, and service.

Thomas Peacock is a leader in the field of nonlinear dynamics, applying ideas and tools from nonlinear dynamics to the systematic study of stratified fluid flows. Such flows occur in many natural and engineering systems through spatial variations in temperature or composition (e.g., salinity in the ocean) and lead to the formation of complex patterns and structures as well as internal waves and large-scale tidal currents. These internal waves are prevalent throughout the ocean and atmosphere; they are

expected to occur whenever stratified fluids interact with local topographic variations or moving boundaries. Tom's leadership in academic service and in organizational and editorial activities has significantly raised the international profile of these phenomena. His laboratory has also recently revealed a novel form of self-propulsion that is associated with the local and spontaneous diffusive flux of stratified fluids near solid boundaries. Tom has established a new experimental capability for nonlinear dynamics within the Mechanical Engineering Department, and through his extensive large-scale observational field work he has helped to reestablish MIT's international reputation in geophysical fluid dynamics. He has invigorated the department's curriculum in linear and nonlinear dynamics at both the undergraduate and graduate levels. He is an excellent lecturer, a popular mentor, and a skilled communicator of scientific ideas. Through his NSF career award he is helping to convey the importance of complex ideas from dynamical systems and the dynamics of stratified fluid flows to a broad public audience.

Alexandra (Alex) Techet is a leader in the field of experimental hydrodynamics. Her research innovatively expands the state of the art in spatial and temporal imaging of complex flow fields and the use of such measurements in understanding the physics of fluid flow in a variety of important hydrodynamic phenomena. She tackles difficult and challenging problems that will have long-term effects, including free surface water entry of projectiles, maneuvering and propulsion of aquatic creatures, and sensing of the water/air interface of breaking waves. Alex has garnered acclaim for her work, with three winning images in the American Institute of Physics's Gallery of Fluid Motion as well as a cover image on the *Journal of Fluid Mechanics* and an Office of Naval Research Young Investigator Award. More important than the beauty of the images is the clarity of the physics, which has provided key physical insights to complex phenomena.

Professor Techet is also a talented and dedicated educator and mentor. She has introduced hands-on design in the freshman year, a hands-on laboratory component for the undergraduate hydrodynamics course, and serves as a valued mentor and teacher in the flagship sophomore design subject 2.007 Design and Manufacturing I. In addition to her roles as lecturer and laboratory professor, Alex has also mentored the award-winning 13 SEAS undergraduate ocean engineering student group as well as numerous SB, SM, and PhD theses. Alex is committed to the vitality and vibrancy of our efforts in ocean engineering education and research, where she has shown leadership in the MIT–Woods Hole Oceanographic Institute Joint Program. She is also the principal investigator and cocreator of a major new education and research initiative, the Naval Engineering Education Consortium, which will educate the next generation of civilian engineering leaders for the Navy. The consortium will work in concert with our graduate program for navy officers.

We were also pleased to report the promotion of professor Kimberly Hamad-Schifferli from assistant professor to associate professor without tenure.

Kimberly (Kim) Hamad-Schifferli holds a dual appointment in the Departments of Mechanical Engineering and Biological Engineering. Professor Hamad-Schifferli has focused her research program on the interface between nanotechnology and biology. She is making significant contributions in the engineering design of nanoparticles

for biomedical applications. The use of nanoparticles to control biologically relevant processes is a rapidly expanding research area because of its potential in disease detection and treatment. Professor Hamad-Schifferli's research program focuses on designing the geometry and surface chemistry of nanoparticles for controlled biomolecule release. She is the first to propose and demonstrate the use of modified gold nanorod size and geometry to release different biomolecules selectively; the technique capitalizes on the size-dependent resonant absorption wavelength of the nanorods to activate release. Her focus on the surface chemistry, which couples the protein molecule to the nanoparticle, has probed the specific chemical interactions and corresponding molecular mechanisms that alter the protein conformation (and its function). This research is providing design rules for protein–nanoparticle linking. She has successfully mentored five doctoral students to completion of their degrees through these projects. Professor Hamad-Schifferli is also recognized as an exceptional educator; in collaboration with professor Linda Griffith, she introduced undergraduate subject 20.011J Statistical Thermodynamics of Biomolecular Systems. This course has grown from a small (seven students) elective to a required core course in Biological Engineering that attracts a 100-student enrollment.

George Barbastathis and Sanjay Sarma were promoted to full professor.

George Barbastathis has established an internationally recognized research and educational program in three-dimensional optical engineering. His research activities are broadly focused in the field of information optics; that is, the processing and analysis of information by systems composed of optical, mechanical, and computational elements. Professor Barbastathis's work is focused in two principal areas: diffractive optics and the emerging area of subwavelength optical engineering using novel three-dimensional assembly methods. His group has pioneered the development of volume holography for imaging of complex systems as well as "nanostructured origami," which leverages the precision patterning that can be achieved using two-dimensional lithography. His research contributions span the spectrum from fundamental theoretical analysis through laboratory-scale demonstration to design of instrumentation. The three-dimensional optical systems developed by his group are now being used in a wide variety of applications, from in vivo imaging of biological tissue and endoscopy to information storage, energy storage, chemical detection, and autonomous environmental sensing.

Professor Barbastathis has been the leader in organizing, developing, and popularizing an optical engineering curriculum within the Department of Mechanical Engineering. His joint undergraduate/graduate subject 2.71/2.710 Optics has been offered continuously for a decade now, and attracts students from across the School of Engineering as well as from other schools at MIT. Outside optics, George is integrally involved with the undergraduate curriculum in the Department of Mechanical Engineering. Barbastathis is also contributing substantially to MIT's international research and distance-learning efforts through his unique role as a key member of two distinct SMART programs.

Professor Sanjay Sarma's research contributions have focused in three areas: manufacturing automation, radio frequency identification (RFID) tags, and distributed and mobile sensors. Sanjay's research in manufacturing automation centered on three major new contributions in machining: reference free part encapsulation, a new design

for a five-axis machine tool, and a five-axis numerically controlled system for machining tool paths; each of these contributions was brought to physical form as well as supported by rigorous modeling in their development. This work is widely recognized by the computer-aided design/computer-aided manufacturing/computerized numerical control (CAD/CAM/CNC) community. His research on RFID tags is internationally recognized by academic and industrial communities. Sanjay spearheaded the development of RFID tags as the new bar code, from concept to large-scale industrial implementation. His RFID work is now recognized as a game-changer in supply chain management and continues to expand into new areas. RFID has been adopted by numerous major companies, has resulted in the formation of several new companies, has led to the development of international standards to guide the use of RFID, and has spawned a new scholarly research field. Sanjay's ongoing research continues to expand RFID into new areas, including its potential to enable fragmented warehousing as an optimal storage and retrieval scheme and the development of RFID-based sensors to enable remote and distributed sensing.

Sanjay is also recognized as a truly exceptional educator in the Mechanical Engineering Department by the faculty and by the students. He is considered a brilliant lecturer who is in touch with the students in a very personable one-on-one manner. He also has an open-door policy with undergraduates that students actively utilize for assistance with coursework as well as for general career advice. He has been recognized by the department with the Keenan Award for Teaching Innovation and the Den Hartog Award for Excellence in Education, and by the Institute, where he has been named a MacVicar Fellow.

Area Overviews

The department has many thriving and vibrant research programs. Faculty organized within seven key areas of mechanical engineering work with their research groups to address global challenges. A brief overview of each of the seven areas follows.

Mechanics: Modeling, Experimentation, and Computation

Understanding and optimizing the mechanical and dynamical response of a material system is essential to its ultimate application, be it a carbon nanotube sensor array, a micromachined turbine, a white blood cell being deformed in a human capillary, or a plate of armor being deformed by a supersonic blast wave. Built upon rigorous disciplinary skills, modern research studies in the broad area known as mechanics involve collaboration across the traditional boundaries of "fluids," "solids," and "dynamics" and feature the intimate interaction of modeling, experimentation, and computation. This is reflected in the collective name of the area, Modeling, Experimentation, and Computation (http://meche.mit.edu/research/mechanics/).

Design, Manufacturing, and Product Development

Design and manufacturing are at the heart of mechanical engineering. Whether it is a steam turbine or a gaming console, it was conceived, designed, fabricated, assembled, and delivered by someone who understands design and manufacturing and the supply chain. Behind the scenes, product design teams, CAD/CAM systems, machine tools, manufacturing processes, planning systems, schedulers, and controllers enable

designers to produce products at the cost, quality, and quantity needed to succeed in an increasingly competitive market.

Today, design and manufacturing must also respect worldwide concerns about sustainability, not just at the concept stage or during manufacture, but also during the product's entire lifecycle, all the way to recycling. These are the topics that the Design, Manufacturing, and Product Development area (http://meche.mit.edu/research/product/) tackles on a daily basis. The faculty and students in this group are diverse, with affiliations not just with mechanical engineering but also with the Laboratory for Manufacturing and Productivity and with other departments. Our group draws from the core disciplinary areas of mechanical engineering, such as mechanics and controls, and addresses many of the challenges facing the world through design and innovation, especially for energy, water, transportation, and health.

Control, Instrumentation, and Robotics

The Control, Instrumentation, and Robotics (CIR) area (http://meche.mit.edu/research/controls/) seeks to promote research into fundamental principles and methodologies that enable systems to exhibit intelligent, goal-oriented behavior, and also into developing innovative instruments to monitor, manipulate, and control systems.

This area is based on strong core disciplinary competencies in dynamic systems and control, supplemented by knowledge of a diverse array of topics, including mechanical design, manufacturing, electronics, materials, and biology.

CIR applications span a broad spectrum of social and national needs, including autonomous, mobile robots for energy exploration, security, defense, and environment monitoring; advanced medical devices and systems for surgery, rehabilitation, and care of the elderly; precision machines for manufacturing, manipulation, and measurement at micro- and nanoscales; novel sensors, actuators, and materials; and humanoid robots for home automation, education, and entertainment.

Energy Science and Engineering

Energy Science and Engineering (http://meche.mit.edu/research/energy/) focuses on technologies for efficient and clean energy conversion and utilization. We aim to meet the challenges of rising energy demand (and prices) and the environmental effects of meeting that demand.

Our program encompasses existing and emerging technologies at the systems, engineering, and scientific levels. Besides engines and combustion, our research covers thermoelectricity, fuel cells and batteries, solar energy and wind power systems, energy efficient buildings, carbon capture, hydrogen and alternative fuels, and water purification and desalination.

Our efforts in technology are grounded in fundamental research in the thermodynamics of coupled processes; thermochemical and electrochemical reaction and transport processes; heat and mass transfer; solid-state phenomena, including photo, thermal, and electrical aspects; nanosciences; surface interactions; and fluid dynamics. Tools we develop and apply include computation, diagnostics, experimentation, and analysis.

Bioengineering

In the Bioengineering area (http://meche.mit.edu/research/bio/), we seek to understand the workings of biological systems, from molecules to organisms. By applying engineering principles, we can better appreciate complex integrated biological or physiological systems and develop new diagnostics, therapeutics, and devices to benefit human health and society.

Mechanical engineering covers a broad range of disciplines (materials, mechanics, systems and controls, thermodynamics, fluid mechanics, and design and manufacturing), each of which plays an essential role in bioengineering. Many faculty in our department pursue bioengineering as part of their research portfolio and welcome the participation of graduate and undergraduate students.

Ocean Science and Engineering

The Ocean Science and Engineering area (http://meche.mit.edu/research/ocean/) seeks to advance research and education to better understand, protect, and utilize the oceans, which cover more than 70 percent of the earth's surface. The oceans are still the primary avenue for international commerce and the projection of military power.

Operating in the ocean is demanding because of the wave environment, extreme pressure, and a limited ability to sustain high-data-rate communications. The ocean interior is undersampled both temporally and spatially; forecasting the ocean environment is challenging.

Micro- and Nanoengineering

Tiny systems offer giant opportunities for technology, consumer products, energy systems, and more. Micro- and nanotechnology enable airbag sensors, disposable medical sensors for improved patient safety, rapid DNA analysis, stronger and lighter nanostructured materials for automobiles and airplanes, and both microscale and nanostructured energy conversion devices for improved energy efficiency, to name a few.

Mechanical engineering provides a key foundation for these multidisciplinary advances. Faculty members in our department pursue micro- and nanoscale research (http://meche.mit.edu/research/micronano/) that extends through mechanical engineering as well as other science and engineering disciplines. We continue to add to our significant roster of educational offerings in micro- and nanoscale science and technology. Students interested in micro- and nanotechnology are encouraged to sample these offerings.

Space Renovation Highlights

The Mechanical Engineering Department is privileged to be housed primarily within the original main buildings of the MIT Cambridge campus. With this privilege comes the challenge of conducting 21st-century mechanical engineering education and research in 19th-century buildings. Major renovations of the department's physical space have become necessary to enable the department to remain at the leading edge of mechanical engineering. Renovations have been undertaken to accommodate the research needs

of new faculty members as well as the evolving research needs of current faculty. Laboratory renovations of more than 1,500 square feet of laboratory space on the ground floor of Building 5 for new faculty members Cullen Buie (energy) and Sangbae Kim (robotics) finalize the renovation of the Pappalardo 2 Laboratory. We are also grateful for a very generous endowed laboratory fund established by Neil and Jane Pappalardo to provide for the ongoing maintenance of these laboratory spaces. Renovation of laboratory space on the fourth floor of Building 35 for new faculty member Kripa Varanasi has been completed and renovation of a neighboring laboratory for new faculty member Nick Fang has begun. Renovation of two laboratory spaces—a multivehicle control arena on the ground floor of Building 1 in the d'Arbeloff Laboratories and a biomolecular control laboratory on the third Floor of Building 3 for new faculty member Domitilla Del Vecchio—has been completed. Renovation of a new laboratory cell within Building 31 for Professor Ahmed Ghoniem's expanding research program on carbon capture has been completed, with further renovations planned for the coming year. The upgrading of a major shared student space on the fourth floor of Building 5 was also completed; this space meets the needs of 30 graduate students in ocean sciences and engineering.

The department also completed a major renovation of the Rohsenow Heat and Mass Laboratory this year, refurbishing a laboratory that originally joined the department as the Heat Measurements Laboratory in 1934. This 6,500-square-foot laboratory is shared among faculty in the transport field. It is now fully equipped for studies of heat and mass transfer in nanoscale systems, thermoelectric devices, microfluidic devices, seawater desalination, and other areas; the laboratory includes spaces suitable for high-precision optical measurements, chemical processes, and the study of thermofluid systems of various types. This renovation was made possible through generous support from the Center for Clean Water and Clean Energy (a partnership between MIT and the King Fahd University of Petroleum and Minerals), and through a very generous gift from Gail Kendall, an alumna who earned her PhD with Warren Rohsenow. We are pleased to name this laboratory the Rohsenow Kendall Heat Transfer Laboratory. A dedication ceremony is planned for fall 2010.

The department has also renovated the first floor of Building 1—the Mechanical Engineering Corridor—serving as a gateway through the department for hundreds of visitors to MIT each day. A major element of this renovation was the creation of a new Mechanical Engineering Student Commons at the Massachusetts Avenue corner entrance. This space provides a mixed-use space for the more than 1,000 undergraduate and graduate students in mechanical engineering, enabling individual or team work spaces as well as gathering spaces between classes or on weekends. The renovation of the Mechanical Engineering Student Commons was made possible by a very generous donation of alumnus B.J. Park and his wife Chunghi Park, who had also previously made possible the renovation of the Park Lecture Halls (3-270 and 3-370). The Mechanical Engineering Department is fortunate to have such generous alumni and friends. Additional laboratory and shared student office space renovations are planned for the coming year.

Education Highlights

The dedication of faculty to educating the next generation of engineering leaders continues to be a strong signature of the Mechanical Engineering Department. Innovation in education is prevalent in our Women's Technology Program for high-school juniors, which has established an exceptional record for attracting women to engineering; in our pre-freshman and freshman courses and activities; in our Course 2, 2-A, and 2-OE undergraduate programs; and in our core and advanced graduate curricula. Here, we select a few representative highlights followed by enrollment overviews of our undergraduate and graduate programs.

Pre-Freshman and Freshman Offerings

In recent years, the Department of Mechanical Engineering has offered several courses that introduce pre-freshmen and freshmen to engineering. Our pre-freshman orientation subjects include Discover Mechanical Engineering, Discover Ocean Engineering, and Discover Design and Product Development. These are some of the most sought-out orientation programs and provide hands-on engagement with engineering from the first day a student arrives at MIT.

We also offer the most popular freshman elective: Toy Product Design. This laboratory-based course was developed as an experiment in providing a freshman-level design and engineering course. Toy Product Design has taken on a life of its own; it was recently voted one of *Popular Science* magazine's "most awesome college labs." Toy Product Design is a hands-on, project-based design course that provides an introduction to the product design process with a focus on designing for play and entertainment. Students work in small teams of six or seven members to design and produce full prototypes of new toys. The course takes them through all aspects of the product development process, including determining customer needs, brainstorming, estimation, sketching, graphic design, industrial design drawing, sketch modeling, concept development, design aesthetics, detailed design, and prototyping, and written, visual, and oral communication. Enrollment is limited by available space and has been at full capacity (80–90 students). The course has clearly served as a gateway to engineering and to experiencing engineering in a hands-on way, which aids students when in choosing a major. This is especially true for those students who may not have direct knowledge of or experience with engineering, or confidence in their engineering ability, when they enter MIT.

Micro/Nano Engineering Laboratory

Much research at the frontiers of mechanical engineering involves microscale and nanoscale engineering and devices—understanding and extending mechanical engineering principles down to these small scales, as well as fabricating, processing, measuring, and manipulating at these scales. The Department of Mechanical Engineering has now introduced an undergraduate laboratory subject, 2.674 Micro/Nano Engineering Laboratory, which satisfies a Course 2 degree requirement. Subject 2.674 challenges students to think creatively and to solve multiscale and multidisciplinary problems at the micro- and nanoscales. Students bring fundamental physics, chemistry, fluids, mechanics, and transport knowledge to bear on the behavior of materials and phenomena at the micro- and nanoscales through laboratory modules and imaging tools

on a variety of topics including carbon nanotube arrays, atomic force microscopy, and microfluidics. Enrollment in this subject has grown from six students in 2007 to more than 50 students in 2010.

Robotics

Robotics today encompasses all elements of mechanical engineering and is increasingly multidisciplinary. One of our senior electives, 2.12 Introduction to Robotics, is a popular upper-level elective in the department. Robotics is also a popular track in our Course 2-A degree program, where students take a challenging combination of Course 2 and Course 6 classes to satisfy curriculum requirements. In 2.12, through lectures combined with group projects (centered on a theme—past themes have, for example, included surgical robotics; the theme for fall 2010 is the BP oil well blowout), students learn robotic mechanisms and manipulators, dynamics, motion planning, sensing, and intelligent controls. Students obtain direct experience in the group projects, where together they design and build a robot and its control system to meet a specified need.

Undergraduate Program

Our educational programs remain strong. The Mechanical Engineering Department remains the second largest undergraduate program at MIT, and the trend of growing enrollment is continuing. In particular, we see continuing growth in our groundbreaking Course 2-A engineering major, which can be customized to suit a student's interests.

Undergraduate Enrollment

	AY2006	AY2007	AY2008	AY2009	AY2010
Sophomores					
2	105	98	93	114	76
2-A	35	29	41	51	67
2-OE	4	4	5	6	5
13	0	0	0	0	0
Subtotal	144	131	139	171	148
Juniors					
2	91	104	99	95	112
2-A	25	22	20	44	50
2-OE	1	4	3	4	6
13	4	0	0	0	0
Subtotal	121	130	122	143	168
Seniors					
2	69	87	99	90	80
2-A	41	31	27	26	49
2-OE	1	1	5	4	6
13	4	3	0	0	0
Subtotal	115	122	131	120	135
5th-year students					
2	6	13	12	7	4
2-A	2	1	2	5	5
2-OE	0	0	0	0	0
13	1	0	0	0	0
Subtotal	9	14	14	12	9
Total	**389**	**397**	**406**	**446**	**460**

Undergraduate Honors and Awards

Tanya Goldhaber was named Marshall Scholar, and Omar Abudayyeh was named Goldwater Scholar.

Emily Houston, Leo Luo, Jenna McKown, Samuel Weiss, James White, and Kent Willis were inducted into the Phi Beta Kappa Honor Society.

Omar Abudayyeh, Trevor James Shannon, Katrina Michelle Ellison, Vu Anh Hong, and Eric Robert Reuland were inducted into the Tau Beta Pi Engineering Honor Society.

Omar Abudayyeh, Stephanie Brown, John Boghossian, Mindy Eng, Evan Lampe, Tanya Goldhaber, Lauren Hernley, Vu Anh Hong, Zachary Rose, Ian Rust, Amrita Saigal, Katrina Schoen, Will Vega-Brown, and Kent Willis were inducted into the Pi Tau Sigma Mechanical Engineering Honor Society.

The Department Service Award for Outstanding Service to the Mechanical Engineering Department was awarded to Erika Bildsten, John Boghossian, Toomas Sepp, Katrina Schoen, Tish Scolnik, and William Vega-Brown.

Kevin Rustagi and Evan Schneider won the B.J. and Chunghi Park Award for Outstanding Performance in Manufacturing.

Matt Gildner and Leah Hokanson received the Society of Naval Architecture and Marine Engineering Award for Outstanding Undergraduate in the Marine Field.

Roberto Melendez was given the Alfred A.H. Keil Ocean Engineering Development Fund Award for Excellence in Broad-Based Research in Ocean Engineering.

Michaelle Mayalu received the John C. and Elizabeth J. Chato Award for Excellence in Bioengineering.

Katherine M. Snyth was awarded the Peter Griffith Prize for Outstanding Undergraduate Thesis.

Vibin Kundukulam, Emily Shao, and Richard Larson won the AMP Inc. Award for Outstanding Performance in Course 2.002.

Wunsch Foundation Silent Hoist and Crane Awards went to the following students:

Academic Excellence: Nadia Tepper, Jenna McKown, Samuel Weiss

Outstanding Undergraduate Student: Trevor Shannon

Outstanding Thesis: John A. Williams

Laura War and Brett van Zuiden were awarded the Whitelaw Prize (Originality in 2.007 Design and Contest).

Randall Briggs, Dan Fourie, Joseph Conte, and John Romanishin won the International Design Competition (2.007 Contest).

Luis de Florez Awards for Outstanding Ingenuity and Creativity were given to the following students:

Undergraduate Design Award: Andrew Marecki

Audience E-mail Competition: Samuel Weiss

Gregory Tao received the Thomas Sheridan Prize for Academic Excellence by a Graduating Senior.

Emily Houston won the Lauren Tsai Memorial Award for Academic Excellence by a Graduating Senior.

Josh Leighton and Daniel Hanks were given the American Bureau of Shipping Award for Advanced Research in Marine Engineering and Naval Architecture.

Graduate Program

Our graduate program continues to be strong, with a total of 480 students; 88 are women, 33 are members of underrepresented minorities, and 215 are international students. Our students are supported primarily by research assistantships. Fellowships are a primary means to attract truly exceptional talent, including NSF fellowships, Department of Defense fellowships, internal fellowships endowed through the generosity of alumni and friends (including the Rohsenow, Shapiro, Harrington, Bailey, Lee, Sonin, Martin, Cook, Pappalardo, ABS, DuPont–MIT Alliance, and Energy Initiative fellowships), Institute Presidential Fellowships, and fellowships from other sources. Our graduate program attracts a very talented applicant pool and we continue to attract excellent students despite the increasingly aggressive recruitment of our competitors.

Graduate Enrollment, AY2007–AY2010

	AY2007	AY2008	AY2009	AY2010
Masters	209	208	204	201
Doctoral	260	236	244	262
Total	**469**	**444**	**448**	**463**

Graduate Honors and Awards

Lisa Burton won the Meredith Kamm Memorial Award for Outstanding Woman Mechanical Engineering Graduate Student.

Amos Winter received the School of Engineering Graduate Student Extraordinary Teaching and Mentoring Award.

Luis de Florez Awards for Outstanding Ingenuity and Creativity went to the following students:

Graduate Design Award: Conor Walsh

Graduate Science Award: Jonathan Hopkins, Robert Panas

Jesse Austin-Breneman, Barry Kudrowitz, and Geoff Tsai were awarded the Carl G. Sontheimer Prize for Creativity and Innovation in Design.

Wunsch Foundation Silent Hoist and Crane Awards were given to the following students:

Outstanding Graduate Student: Sheng Shen, Reza Sharifi Sedeh

Outstanding Graduate Research: Hyukmin Kwon, David Smith

Outstanding Teaching Assistants in Course 2.002: Ashley Browning, Benjamin Druecke

Outstanding Teaching Assistants in Course 2.007: Shane Colton, Mohammad Imani-Nejad

Outstanding Teaching Assistants in Course 2.674: Marco Cartas

Outstanding Performance, Course 2N: Jon Gibbs, Roberto Urrutia, Phil Menard

Bret S. Smart won the Clement C. Burnap Award for Outstanding Master of Science in the Marine Field.

Jordan Stanway received the Link Foundation Fellowship for Creativity and Innovation in Design.

The R&D 100 Award (Leveraged Freedom Chair) was given to Amos Winter, who was also named a Fulbright Scholar.

Faculty Notes

Many faculty members have been recognized with the awards and appointments. A partial list follows.

Rohan Abeyaratne received the 2010 Applied Mechanics Division Drucker Medal of the American Society of Mechanical Engineers (ASME).

Arthur Baggeroer was named a member of the Committee on National Security Implications of Climate Change on US Naval Forces.

George Barbastathis was promoted to full professor.

Cullen Buie was appointed Mitsui assistant professor.

Tonio Buonassisi and his students won the best poster award at the European Materials Research Society, Strasbourg, France.

Stephen Crandall received the ASME 2009 Thomas K. Caughey Dynamics Award.

Gang Chen was elected a fellow of the American Association for the Advancement of Science and was elected into the National Academy of Engineering.

Chryssostomos Chryssostomidis was appointed by President Obama to the task force investigating the April 20, 2010, BP oil well blowout in the Gulf of Mexico.

Domitilla Del Vecchio received the 2010 American Automatic Control Council Donald P. Eckman Award and was appointed W.M. Keck assistant professor in biomedical engineering.

Dan Frey became principal investigator, International Design Center of the Singapore University of Technology and Design.

Kimberly Hamad-Schifferli was promoted from assistant professor to associate professor.

Anette (Peko) Hosoi was named a MacVicar Fellow in recognition of truly exceptional teaching.

Roger Kamm received AMSE's 2010 H.R. Lissner Medal in recognition of his many original contributions to the field of bioengineering; was named Singapore research professor of biological and mechanical engineering; and was elected a Fellow of the American Association for the Advancement of Science.

Rohit Karnik received an NSF CAREER Award.

Sangbae Kim was appointed Esther and Harold E. Edgerton career development assistant professor.

John J. Leonard was named director of the MIT–Ford Alliance.

Pierre Lermusiaux received the Joel and Ruth Spira Award for Excellence in Teaching.

Carol Livermore and her students won the Best Student Paper Award at the 2009 International Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS).

Alexander Mitsos was appointed Rockwell International assistant professor and received a Best Practice Award from *Bio-IT World* for research and discovery in life sciences.

Nicholas Patrikalakis was named Singapore research professor of robotics and sensing.

Thomas Peacock was promoted to associate professor with tenure.

Pedro Reis was appointed Esther and Harold E. Edgerton assistant professor.

Sanjay Sarma was promoted to full professor and named MIT director at the Singapore University of Technology and Design.

Warren Seering was named codirector of the Systems Design and Management Program.

Alexander Slocum was appointed by US Secretary of Energy Chu to serve on a five-person Team to consult on, aid in relieving the effects of, and find a technical solution to the British Petroleum oil well blowout.

Alexandra (Alex) Techet was promoted to associate professor with tenure.

Kripa Varanasi won the Best Paper Award, 2010 IEEE–ASME ITherm Conference (Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems), a 2010 Young Faculty Award from the Defense Advanced Research Projects Agency, and a 2010 NSF CAREER Award.

Lynette Jones was promoted to senior research scientist.

Amy Smith was named one of *Time*'s 100 most influential persons of 2010.

Staff Awards were given as follows:

Mechanical Engineering Caloggero Award (2009): Caroline Johnston

Mechanical Engineering Trohon Award (2010): Mary Ellen Sinkus

Mechanical Engineering Caloggero Award (2010): Thea Szatkowski

School of Engineering Ellen J. Mandigo Award for Outstanding Service: Leslie Regan

We are also pleased to have introduced a department newsletter, MechE Connects, as a means of maintaining connection with our many alumni. The first edition of MechE Connects was sent to alumni in spring 2010. The newsletter will be published in hardcopy as well as made available on our website (http://mecheconnects.mit.edu/) twice a year, in the fall and spring terms.

Finally, we have taken on a history project in preparation for MIT150 and look forward to providing a timeline of the department's achievements in next year's report.

Mary C. Boyce
Department Head
Gail E. Kendall Professor of Mechanical Engineering

More information about the Mechanical Engineering Department can be found at http://meche.mit.edu/.